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INCORPORATING HEALTH STATUS INDICATORS INTO THE MEASUREMENT OF MEDICAL UNDERSERVICE

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Public Health Service
Health Resources and Services Administration

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HRSA Project No. 86-170
Contract No. 240-86-0056
Task Order No. 240-86-0504

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Public Health Service
Health Resources and Services Administration

ACKNOWLEDGMENTS

This study, HRSA Project No. 86-170, was produced under Contract No. 240-86-0056, Task Order No. 240-86-0504, for the Health Resources and Services Administration by Lewin/ICF.

This report was prepared with the assistance of many individuals and organizations in Maryland, Massachusetts, and North Carolina who provided data and information, time, and insight into problems of access to primary care within their states. These included many state and local government officials, health care providers, and representatives from primary care associations.

We want to especially acknowledge the efforts of the Advisory Committee who assisted in selecting the sentinal events, advised on methodology, and reviewed findings. The Advisory Committee included:

- Donna Bacchi, M.D.
  Former Associate Director
  Brownsville Community Health Center

- Timothy Carey, M.D.
  Assistant Professor of Medicine
  University of North Carolina

- "Andy" Jordan
  Region III
  Bureau of Health Care Delivery and Assistance
  Department of Health and Human Services

- JoAnne Lukomnik, M.D.
  Jersey City Medical Center

- David Siscovik, M.D.
  Clinical Epidemiologist
  University of Washington

- Joyce Young, M.D.
  Bureau of Health Care Delivery and Assistance
  Department of Health and Human Services

We also wish to thank the following people on the staff of Lewin/ICF: Judy Arnold, Ann Zuvekas, Jack Needleman, and Pamela Hochberg, who were principal authors; Sam Zuvekas, a summer intern who conducted most of the data analysis; and Rhonda Greene, who coordinated the production of the report.

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EXECUTIVE SUMMARY

The Health Resources and Services Administration (HRSA) has responsibility for much of the federal government's activity in providing health care resources to those individuals lacking access to care. These activities include the community health center, migrant health center, and National Health Service Corps programs. HRSA program officials are continually faced with difficult decisions about properly allocating scarce federal resources to those most in need of care. To assist in resource allocation, HRSA officials rely on the Health Manpower Shortage Area (HMSA), Medically Underserved Area (MUA) designations, and Need/Demand Assessment to measure underservice. Many state and local programs also rely on these federal methods for identifying high-need areas.

This study is part of a larger effort by HRSA to explore moving away from measures of underservice based predominantly on utilization and resource availability to making greater use of health status measures. The impetus for HRSA's reexamination of its resource allocation processes is a concern that current measures of underservice do not adequately reflect recent demographic and health system changes and thus may not adequately identify areas in greatest need. While resource availability and utilization measures were adequate when there were substantial discrepancies between health service use by middle- and upper-income populations and the poor, these measures are no longer sufficient.

A. SELECTION OF SENTINEL HEALTH EVENTS

The concept of sentinel health events offers an opportunity to develop a more sophisticated approach to measuring underservice. Sentinel health events are certain medical conditions or stages of conditions that indicate a lack of access to acceptable quality primary

care. For this study, which focuses on access to primary care, medical conditions can be sentinel events only if primary care could have prevented the condition or a stage of the condition, or reduced the prevalence of the condition. Sentinel events may be marked in three ways:

- **Existence of the condition**. Some conditions, by their very existence, reflect barriers in access to care. These are conditions which never need occur if individuals are receiving ongoing primary care. For example, all children should be immunized against measles and should not contract the disease. (However, in reality we may see a few cases of measles resulting from immunization failure).

- **Stage of the condition**. Some conditions occur in the population regardless of health service use. Diabetes and hypertension are examples of such conditions. However, since ongoing patient management can be effective in controlling the disease, the presence of advanced or uncontrolled stages can indicate a problem with access to care. For example, hospitalization as a result of ketoacidosis in diabetics should not occur if the patient is receiving ongoing patient management.

- **Higher than expected rates**. These are conditions, such as low birth weight in infants, that are never going to disappear, but the prevalence can be reduced. For these conditions, we are interested in how the prevalence in certain populations compares with the average prevalence of the condition and with the prevalence among comparison groups.

The concept of sentinel events dates back to the 1960s when researchers posited their use as measures of quality of care. This study took them a step further, testing their use as measures of access to care. In consultation with an Advisory Committee of experts on access to care and examination of the literature on sentinel health events, we used four criteria to select sentinel events:

- The sentinel event is well defined, and the condition can be easily diagnosed.

- Primary care patient management is effective in preventing, treating, or controlling the condition.

- The sentinel event must be observed in the population.
- Data are routinely collected on the condition and might be made available in many communities within reasonable cost and time constraints.

Fourteen sentinel health events were selected to be tested as indicators of a lack of appropriate primary care patient management. The events and the data sources used to measure them are listed in Table I-1.

B. CALCULATING SENTINEL HEALTH EVENTS

Identifying geographic areas or population groups as potentially underserved involves calculating the relative rate of sentinel events among different areas and/or population groups. An area or population group with significantly higher rates of several sentinel events than other areas or population groups is identified as potentially underserved.

The comparison requires calculation of a relative risk ratio, or the rate of a sentinel event in one area or population group divided by the rate of the sentinel event in another area or population group. For example:

$$\frac{\text{Incidence of measles in West Baltimore}}{\text{Incidence of measles in Baltimore MSA}} = \text{Relative Risk of Measles in West Baltimore}$$

The above equation first requires calculating the incidence or admission rate for each event in each area or population group. An incidence rate is the rate of occurrence of an event in the community. For example:

TABLE I.1

SENTINEL EVENTS USED IN FIELD TESTING

EVENTS	DATA SOURCE	DENOMINATOR
Infants		
Hyperbilirubinemia with exchange transfusion	Hospital discharge data	Infants:total and by race
Dehydration	Hospital discharge data	Infants:total and by race
Children		
Asthma	Hospital discharge data	Children age 1-14:total and by race
Hearing loss from otitis media	School hearing tests	Grades pre-k through ninth
Measles, Mumps, Polio, Tetanus	Public health department	Children age 1-14:total and by race
Peritonitis	Hospital discharge data	Children age 1-14 with appendicitis
Rheumatic Fever	Hospital discharge data	Children age 1-14:total and by race
Adults		
Advanced Breast Cancer	Tumor registry	Females:total and by age, race and stage
Advanced Colorectal Cancer	Hospital discharge data, tumor registry	Adults:total and by age, race and stage
Invasive Cervical Cancer	Hospital discharge data, tumor registry	Females:total and by age, race and stage
Low Birth Weight	Birth certificates	Births:total, by race, age of mother and prenatal care
Uncontrolled Diabetes	Hospital discharge data	Adults:total and by sex, age, and race
Uncontrolled Hypertension	Hospital discharge data	Adults:total and by sex, age, and race
Tuberculosis	Public health department	Area population:total, by sex and race

$$\frac{\text{Cases of Measles in West Baltimore}}{\text{Children ages 1-14 in West Baltimore}} = \text{Incidence of Measles in West Baltimore}$$

From the incidence rates, we calculated the relative risk ratio between two groups. A relative risk ratio of 1.0 represents no difference between the two groups. A relative risk ratio greater than 1.0 indicates that one population has a greater chance of having the event than the other population. For example, a relative risk ratio of 1.5 indicates that a population has a 50 percent greater risk of having the event than the other population.

These ratios raise the question, how much is too much? Does a ratio of 1.5 indicate a significant problem, or should the number be 1.1, or 3.0? Clinical significance and not statistical significance was used as the criterion for judging whether an area has too much of a sentinel event. Measures of statistical significance were not necessary in this analysis since we used the entire population of an area and not a sample of the area. Judgments of clinical significance were made using specific thresholds, determined in consultation with the Advisory Committee. They should be used as guidelines for determining clinical significance but should not be taken as absolutes. The thresholds can be increased or decreased and the results compared to determine whether the conclusions change as the thresholds change.

C. EFFECTIVENESS OF THE SENTINEL EVENT METHOD

The method was field-tested in two urban and two rural sites. These include Baltimore and Boston and two rural counties in both Massachusetts and North Carolina. The method proved to be effective in urban areas. In rural areas the findings were inconclusive. Further analysis is required to determine the effectiveness of the method in rural areas.

The method identifies areas with apparent health status problems that could then be further studied to confirm whether and what barriers existed to obtaining appropriate primary care; it has potential to be used as a planning tool to help target resources and services to specific population groups.

1. Identifying Possible Areas of Underservice

The sentinel event method is effective as a tool for identifying underserved areas:

- Sentinel Event Method Does not Identify Areas at Random. Areas found to have significantly high rates of sentinel events in Baltimore and Boston are areas we would expect to identify, based on what is known about the characteristics of underserved populations.

- The Method Identifies Areas Which Match Areas Designated by Other Measures of Underservice. It surfaces many of the same areas as HMSA and MUA methods.

  -- Many of the sentinel event areas are high poverty. However, some sentinel event areas are not high poverty.

  -- The uninsured and the Medicaid population have high rates of sentinel health events.

- The Method Identifies Areas which, while not Identified by Other Measures, Appear to Be Underserved when Examined in Other Ways.

2. Targeting Resources to Specific Population Groups

A second goal of the sentinel event method is to enable program managers and policy makers to identify particular population subgroups at risk, so that program managers and community health center directors can use the method to target health services to specific age, race, or sex cohorts.

Based upon the analysis in Baltimore and Boston, it would appear that the sentinel event method has potential for use as a planning tool to target specific populations, although not to identify what services should be provided.

D. NEXT STEPS

The sentinel event method appears to identify areas or populations that may be missed by other methods. At its present stage of development, the method can best be used as a supplement to existing methods but not as a replacement for them. More work is needed on validating the method and putting the necessary data systems in place throughout the country. In the short-term the method can:

- Guide the inclusion of health status indicators into HMSA and the Need/Demand Assessment.
- Aid those states and local areas that already have good data sets to plan their use of health care resources.
- Assist primary care networks, state agencies operating under Cooperative Agreements, and primary care associations to do more sophisticated and realistic planning for care.

In the longer run the sentinel event method has the potential for playing a larger role in flagging areas and populations with needs:

- The method could be applied to larger areas and, perhaps, the whole United States.
- The method could substitute for existing methods, particularly when data are lacking for the HMSA and MUA processes.
- The method might be used to evaluate the outcomes of health programs.

Among the next steps that HRSA can take are:

- Taking a closer look at the high sentinel event areas in Baltimore and Boston.
- Comparing the incidence rates for the sentinel events in the test sites with those for the nation as a whole.
- Conducting further tests in rural areas.
- Developing a manual for a model sentinel event method and then assisting two to three states or local areas to try it for themselves.

Implementing the method requires continued growth in the development of state and federal health data bases. Additional information that would facilitate implementing the method are:

- Geocode the patient's address into areas smaller than zip codes.
- Information on the patient's income level.
- Information on health insurance status.

CHAPTER ONE
INTRODUCTION

The Health Resources and Services Administration (HRSA) has responsibility for much of the federal government's activity in providing health care resources to those individuals lacking access to care. These activities include the community health center, migrant health center, and National Health Service Corps programs. HRSA program officials are continually faced with difficult decisions about properly allocating scarce federal resources to those most in need of care. To assist in resource allocation, HRSA officials rely on the Health Manpower Shortage Area (HMSA), Medically Underserved Area (MUA) designations, and Need/Demand Assessment to measure underservice. Many state and local programs also rely on these federal methods for identifying high-need areas.

This study is part of a larger effort by HRSA to explore moving away from measures of underservice based predominantly on utilization and resource availability to making greater use of health status measures. The impetus for HRSA's reexamination of its resource allocation processes is a concern that current measures of underservice do not adequately reflect recent demographic and health system changes and thus may not adequately identify areas in greatest need.

This study was designed to develop, test, and refine a tool which incorporates health status indicators into traditional methods of resource allocation for use by federal, state, and local policy makers and program managers. The project addresses the following questions about this tool, termed the "sentinel health event method":

- Does the sentinel event method identify possible areas of underservice?

- Can sentinel events be used to target resources to specific population groups?
- Is the method practical for use by policy makers and program managers?

This chapter describes the existing methods of measuring underservice and introduces the concept of "sentinel health events." Chapter Two summarizes the study itself; Chapter Three evaluates the effectiveness of the sentinel event method; Chapter Four discusses the practicality of the method and describes one model approach to using the method; and Chapter Five defines the next steps needed to refine the method and implement it.

A. EXISTING METHODS OF MEASURING UNDERSERVICE

Early efforts at resource allocation were largely based upon geographic designation processes relying on utilization and resource availability as measures of underservice. The existing approaches to measuring underservice and allocating resources, and the criticisms of these approaches, are described below.

1. Medically Underserved Areas (MUA)

The MUA designation process has existed since 1974 and currently serves two major functions: 1) to designate priority funding for community health centers, and 2) to provide for special reimbursement arrangements between the Medicare and Medicaid programs and mid-level practitioners who function in rural MUAs under the Rural Health Services Act. The process is not used for placement of federal service-contingent health professionals through the National Health Service Corps, a function reserved for HMSA.

MUAs are designated using the Index of Medical Underservice (IMU), which predicts how a panel of experts would judge the relative

level of medical underservice in specific geographic areas. The index is constructed using four variables: the population-to-physician ratio for primary care, percent of the population below the poverty level, infant mortality rate, and percent of the population over age 65.

A number of technical and methodological criticisms have been made of the IMU. Criticism has focused on the lack of a theoretically based definition of underservice, the failure of the index to directly reflect programmatic concerns, and the tendency of the index to produce anomalous results if one of the variables is particularly skewed.

2. Need/Demand Assessment

In 1981 the Bureau of Health Care Delivery and Assistance (BHCDA) created the Need/Demand Assessment process for community health centers to supplement the MUA designation. The MUA process was the first step in identifying underserved areas, while the Need/Demand Assessment permitted a closer examination of community health centers' service areas and targeted populations.

Now required as part of the centers' grant application, the process estimates the demand for primary health care in the service area and then compares that demand to the estimated supply in the service area and contiguous areas. The Assessment is clearly a step beyond MUA in its understanding of local conditions. Nonetheless, it has also been subjected to criticism. The major criticisms of the Need/Demand Assessment are the lack of satisfactory health status measures and unclear standards for setting priorities among centers. Furthermore, the present Need/Demand process does not permit an aggregation of data (even within one city) to provide a snapshot of the overall area.

3. Health Manpower Shortage Area (HMSA)

The HMSA designation process has been the principal measure for targeting federal resources in placement of health professionals through the National Health Service Corps Program. To be designated as a primary care HMSA, a geographic area must satisfy three criteria:

- Tne area must be a rational service area for the delivery of primary health care.
- It must have a population to primary care physician ratio of at least 3,500:1. If the population-to-physician ratio falls between 3,500:1 and 3,000:1, the area must demonstrate unusually high need for primary care medical services or insufficient capacity of existing primary care providers.
- Primary care physicians in contiguous areas must be demonstrated to be overutilized, excessively distant, or inaccessible to the population of the area under consideration.

A population group may be designated as a HMSA for primary care if it can be demonstrated that access barriers prevent its members from using providers in the geographic area in which they live. In addition, facilities eligible to be designated as HMSAs include medium- and maximum-security federal and state correctional institutions and public or non-profit private residential facilities.

The HMSA criteria have been subject to a great deal of criticism. The major criticisms focus on the weakness of population-to-physician ratios and utilization measures. Population-to-physician ratios measure the availability of health services rather than identifying barriers to access. As a result, medical underservice in sparsely populated rural areas and some confined urban areas may be overlooked.

B. HEALTH STATUS MEASURES

Health status, while recognized as an important marker of barriers to access to care, has not been generally incorporated into federal measures of medical underservice. An exception is the use of infant mortality in designating MUAs and for adjusting the limits of population-to-physician ratios for HMSAs. However, recent changes in health service utilization patterns have created a need to modify current methodologies: while resource availability and utilization measures were adequate when there were substantial discrepancies between health service use by middle- and upper-income populations and the poor, these measures are no longer sufficient. Four factors contribute to the need for a more sophisticated approach to measuring underservice:

- Geographic boundaries are blurring as the demographic composition of the inner city and some rural areas is changing. In an area where a segment of the population lacks access to care, the area may not be recognized as one of underservice because the entire population does not have an access problem.

- As a result of an expanding physician supply, physicians are dispersing into areas where they previously were not present, but their services may not be readily accessible to all area residents. For example, physicians may not be available full-time but split their practices between suburban and inner city locations. Even those physicians apparently available to poor populations may not actually accept Medicaid and the uninsured, thus limiting these patients' actual access.

- Some populations may exhibit high utilization rates, particularly of emergency rooms, but they may still lack access to quality primary care. The care they receive in emergency rooms is often episodic and is not continuous, primary care. As a result, some populations may be deferring care, especially for chronic conditions.

- The availability of Medicaid has increased health care utilization in some poverty areas, but many uninsured may not have access to care.

Relying solely on resource measures of medical underservice is not sufficient for measuring barriers to access to care. Program managers have begun to focus on methods other than utilization and resource availability to examine access barriers.

Since the late 1960s a number of studies have suggested incorporating health status into measures of access. Several studies (Andersen, Davis, and Kleinman) have found that some groups have lower health status than other groups despite almost equal utilization levels. Since the poor continually report lower health status than the non-poor, many approaches have been developed to adjust utilization statistics for health status or to account for the effect of health status on utilization. The use-disability ratio developed by Aday and Andersen and econometric techniques applied by Davis and Reynolds are examples of these approaches.

Work by Rutstein and the National Academy of Sciences in the early 1970s explored the possibility of using sentinel health conditions to measure quality of care and appropriate delivery of care. Rutstein developed indices based on all unnecessary diseases, disabilities, and untimely deaths to indicate where care may need to be improved. Another approach similar to Rutstein was taken by Kessner with the National Academy of Sciences to evaluate health services received by different groups in the population. The research was based on the premise that specific health problems could serve as tracers in analyzing health care delivery. Six possible tracer conditions were identified including middle ear infection and hearing loss, iron-deficiency anemia, hypertension, urinary tract infections, and cervical cancer. As a set, the tracers could be used to evaluate the ambulatory care received by the population.

While these approaches are largely theoretical, they represent a first step at using health status measures to identify problems in access to care. However, over the past decade little has been done to

build upon the work by Rutstein and Kessner and practically apply the concept of sentinel health conditions to examining access to care in communities. The lack of progress in the practical application of a sentinel event method reflected the dearth of the necessary data sets, the information systems and inexpensive computer technology needed to test it. By the late 1980s, as these data became more readily available, inclusion of health status measures appeared more feasible.

C. SENTINEL HEALTH EVENTS

The concept of sentinel events offers an opportunity to develop a more sophisticated approach to measuring underservice. Sentinel health events refer to certain medical conditions or the stage at which they are treated that signal a lack of access to acceptable quality primary care. For example, invasive cervical cancer in older women may indicate that they did not receive Pap smears or that their conditions were not diagnosed and treated at an appropriately early stage. By using a set of clinical indicators to measure health status among population groups, we can develop a better measure of the need for medical care and identify barriers to access to care.

The sentinel event method may offer the opportunity to identify areas or population groups who have problems in gaining access to care but who are missed by current methods of identifying medical underservice. In the long run the method may also provide a means to evaluate the outcome of applying resources and programs by measuring the health status results of the intervention.

The purpose of this project was to move beyond the theoretical and to test the effectiveness and practicality of using sentinel events to measure barriers to access. The remainder of the report describes the approach to and the results of field-testing the method in Baltimore, Boston and two rural counties in both Massachusetts and North Carolina.

CHAPTER TWO
TESTING THE SENTINEL EVENT METHOD

Developing the method involved selecting the sentinel events and then designing the initial method to be tested. Once an initial method was developed, it was field-tested to determine its effectiveness in identifying underserved areas and its practicality.

This chapter describes the development of the sentinel event method and its testing in parts of Maryland, Massachusetts, and North Carolina. It describes the selection of events, the development of the initial method, and the field testing.

A. SELECTION OF SENTINEL HEALTH EVENTS

Sentinel health events are certain medical conditions and/or stages of conditions that indicate a lack of access to acceptable quality primary care. For this study, which focuses on access to primary care, medical conditions can be sentinel events only if primary care could have prevented the condition or a stage of the condition, or reduced the prevalence of the condition. Sentinel health events may be marked in three ways:

- **Existence of the condition**. Some conditions, by their very existence, reflect barriers in access to care. These are conditions which theoretically never need occur if individuals are receiving ongoing primary care. For example, all children should be immunized against measles and should not contract the disease. (However, in reality we may see a few cases of measles resulting from immunization failure).

- **Stage of the condition**. Some conditions occur in the population regardless of health service use. Diabetes and hypertension are examples of such conditions. However, since ongoing patient management can be effective in controlling the disease, the presence of advanced or uncontrolled stages can indicate a problem with access to care. For example, hospitalization as a result of ketoacidosis in

diabetics should not occur if the patient is receiving ongoing patient management.

- **Higher than expected rates**. These are conditions, such as low birth weight in infants, that are never going to disappear, but the prevalence can be reduced. For these conditions, we are interested in how the prevalence in certain populations compares with the average prevalence of the condition and with the prevalence among comparison groups.

With these different types of events in mind, we selected sentinel events for testing.

1. Criteria for Selecting Sentinel Events

In consultation with experts on access to care and examination of the literature on sentinel health events, we used four criteria to select sentinel events:

- The sentinel event is well defined, and the condition can be easily diagnosed.
- Primary care patient management is effective in preventing, treating, or controlling the condition.
- The sentinel event must be observed in the population.
- Data are routinely collected on the condition and might be made available in many communities within reasonable cost and time constraints.

The criteria are described below.

a. The Event Is Well Defined and the Condition Can Be Easily Diagnosed

A condition should be easily diagnosed and its cause clearly identified, since uncertainty about whether a case exists or its cause may raise doubts whether access to primary medical care would have made a difference. The condition should be identified through routine

patient management and not require a specialist to detect. This assures that we are testing access to primary care and not comparing access to specialist or inpatient care.

b. Primary Care Patient Management Is Effective in Preventing, Treating, or Controlling the Condition

A sentinel event should be a condition that can be managed by basic medical care and does not require advanced medical techniques to detect or control. Conditions such as "failure-to-thrive" and meningitis that are not prevented or controlled by good primary care were therefore not appropriate for this purpose. On the other hand, even conditions that require modifying patient behavior (such as changing the diet of diabetics) for successful management were included if aggressive primary care efforts have been shown to make a difference.

We sought to limit the extent to which practice patterns play a role in the treatment or management of the medical condition, since variation in practice patterns may result in more or fewer hospitalizations for the same conditions and hospitalization was being used as the sentinel marker. For example, arthritis would not be appropriate, since some physicians would choose to hospitalize patients for treatment while others would not, even if the patients' conditions were identical.

c. The Sentinel Event Must Be Observed in the Population

The selected events must occur in the population so that: 1) there are enough cases to permit small area analysis and to allow comparison among different subareas, ethnic groups, or income groups; and 2) enough cases exist to make inferences about access to primary care. For each event the judgment about the number which constitute enough cases may vary. For some, such as rheumatic fever and measles, the presence of a single case would be cause for concern, while for others, such as low birth weight, a higher than expected number of cases in an area would be cause for concern.

d. **Data Are Routinely Collected on the Condition and Might Be Made Available in Many Communities within Reasonable Cost and Time Constraints**

For the technique to be useful on a wider scale, the data used to identify the events should be routinely collected and available in the community. The conditions selected can be measured using data from several sources including hospital discharge data, birth certificates, tumor registry, school screening records, and vital statistics. Conditions that require primary clinical data collection, such as measuring blood pressure, have not been selected. Data collection should be undertaken within reasonable cost and time limits and without special technical expertise.

In addition to these four criteria, we also thought it critical that the events be representative of different age and sex cohorts. By examining events for specific population groups, it may be possible to isolate specific age/sex groups facing barriers to access to primary care. For example, providers may have succeeded in bringing adults into the health care system through outreach efforts, but infants and children may still face barriers in the same communities. This may be observed by low rates of adult conditions such as advanced cancers and uncontrolled diabetes and hypertension, but high rates of children's conditions such as dehydration, asthma, measles, and rheumatic fever.

2. **Process for Selecting the Events**

Selecting the sentinel events was a two-step process: 1) an extensive literature review of potential events; and 2) convening an Advisory Committee to aid in selection of events and design of the method.

a. Literature Review

We conducted an extensive literature review of medical conditions that could serve as sentinel events. The possible candidates for inclusion were first identified in consultation with experts on access to care and clinicians specializing in primary care and preventive health. We reviewed the work of Kessner and Rutstein on using events to measure quality of care and Starfield's studies on child health outcomes to identify additional conditions that should be considered.

The clinical literature on approximately 25 medical conditions was reviewed and the criteria cited above applied to each condition. An evaluation of these 25 conditions against the criteria is provided in the Lewin and Associates' report, "Research Agenda: Identifying Sentinel Health Events to Measure Access to Care" (see Appendix E for bibliography). Those conditions which most closely met the criteria were presented to the clinical Advisory Committee for review.

b. Advisory Committee

An Advisory Committee composed of clinical experts was established to review the list of events, assist in identifying data sources, and guide in testing the method. The Advisory Committee first met in December 1986 to review and refine the preliminary list of events drawn from the literature. At this meeting we debated the merits of each event as an indicator of access to primary care and discussed the data sources to measure the events. A second meeting was held in May 1987 at the conclusion of the first test site to review the findings and suggest further analyses or modifications to the method.

The members of the Advisory Committee represented a balance between clinical expertise and a practical orientation to issues of access to primary care and how these events might be used to measure medical underservice. The Advisory Committee was composed of:

- An epidemiologist who provided guidance on measuring the events and choosing the population base to test the method.
- Two internists who provided a critique of the sentinel events selected for the adult population.
- A pediatrician who practiced in a primary care setting and suggested sentinel events for infants and children.
- A Bureau of Health Care Delivery and Assistance (BHCDA) representative with substantial experience working with the HMSA, MUA, and Need/Demand Assessment methodologies.

A list of the Advisory Committee members is found in Appendix D.

3. Selected Events

From the original 25 events, we selected 14 to be tested as indicators of a lack of appropriate primary care patient management. These events are well defined and easily diagnosed, can be prevented, treated or controlled by primary care patient management, and can be measured with existing data sources. The events, organized by age group, are:

- Infants
  - -- Dehydration
  - -- Hyperbilirubinemia with exchange transfusion
- Children
  - -- Asthma
  - -- Hearing loss from otitis media
  - -- Measles, mumps, polio, tetanus
  - -- Peritonitis
  - -- Rheumatic fever

- Adults
  - -- Advanced breast cancer
  - -- Advanced colorectal cancer
  - -- Invasive cervical cancer
  - -- Low birth weight
  - -- Tuberculosis
  - -- Uncontrolled diabetes
  - -- Uncontrolled hypertension

The 14 sentinel events are described below, with an indication of the experience with each in the testing period.

a. **Infants**

- Dehydration resulting from untreated gastroenteritis or diarrhea. Most infants suffer from diarrhea, but the condition should not lead to dehydration if access to adequate primary care is present. This event is measured using hospital admission rates for dehydration with gastroenteritis. In some instances, infants with diarrhea will become dehydrated so quickly that primary care would not have made a difference in preventing the condition. However, where hospital admission rates for infantile dehydration are greater than expected, we can assume that barriers to primary care exist. This event was included in the final set of sentinel event measures.

- Hyperbilirubinemia with Exchange Transfusion. Hyperbilirubinemia, or jaundice, is a condition common to infants. The condition should not go untreated and require an exchange transfusion. Thus, an exchange transfusion is an indication that care for a jaundiced infant has been delayed. This sentinel event is measured using hospital discharge data and combining ICD-9 codes with the procedure code for exchange transfusion. Since hyperbilirubinemia with exchange transfusion is a rare event, the occurrence of even one event is cause for concern. We omitted this event from the findings because no cases were observed in Baltimore and only three cases were observed in Boston. However, in some states this event may still be a problem and should be included in further field testing.

b. **Children**

- Asthma. Hospitalizations for childhood asthma should not be necessary if a child has access to ongoing primary care. This event was added after the Baltimore analysis at the suggestion of the Advisory Committee. It is measured using hospital discharge data. This event was included in the final set of sentinel event measures.

- Hearing Loss from Otitis Media. This results when a childhood ear infection remains untreated and fluid concentrates in the middle ear. The presence of middle ear infections per se does not indicate access problems. However, hearing loss as a result of otitis media indicates that the disease has progressed to a stage that could have been avoided with access to timely and appropriate primary care. An effort was made to use school hearing test data to measure hearing loss from otitis media. Although all schools conduct hearing tests and maintain records, this event was eliminated because hearing test data were incomplete and could not specifically identify otitis media. School children could not be matched to their home neighborhoods, particularly in Boston, where bussing is common.

- Measles, Mumps, Polio, and Tetanus. This combined sentinel event identifies barriers to access to immunizations. Immunizations against all four of these diseases are effective in preventing the diseases. We combined these for analysis because testing them individually would have resulted in too few cases. Despite the importance of immunization, some children are not being immunized, perhaps because of the lack of a place to receive the immunization, lack of knowledge about the importance of immunization, or lack of money. Since states are required to report the cases of these diseases to the Centers for Disease Control, data are obtained from state or local health departments. An occurrence of any of these events may be an indication of lack of access to care.

- Peritonitis. Peritonitis usually results from a ruptured appendix and should not occur in populations with good access to care. This event was added after the completion of the Baltimore analysis. The occurrence of appendicitis itself is not related to access, while peritonitis may represent delayed care. This event and the denominator are measured using hospital discharge data. Peritonitis was later dropped as a sentinel event because we observed no difference in rates among areas; therefore it did not prove to be related to access to primary care.

- Rheumatic Fever. This is a relatively rare condition that may develop from an untreated streptococal infection. The measure of rheumatic fever is taken from hospital discharge summaries. We do not expect to see many cases of rheumatic fever, but the occurrence of one case is of concern and may indicate barriers to access.

c. Adults

- Advanced Breast Cancer can be prevented with access to routine primary care. Although breast cancer is a fairly common disease among women, it should not progress to more advanced stages. Data on advanced breast cancer are obtained from the state tumor registry in Massachusetts. (Neither Baltimore nor North Carolina has a complete tumor registry.)

- Advanced Colorectal Cancer is preventable if the disease is detected and treated in early stages. Advanced colorectal cancer is theoretically a good sentinel event for three reasons: (1) it may be diagnosed and treated at an early stage, (2) physicians should routinely screen for it among the middle aged and elderly, and (3) treatment for early stage, localized colorectal cancer is highly effective. Data for advanced colorectal cancer were obtained from the tumor registry and hospital discharge data base. In using hospital discharge summaries, ICD-9 codes were combined with procedure codes to identify advanced stages. This event was dropped because high rates were observed in high income and low income areas; it appeared that access to colorectal cancer screening was a problem for all populations.

- Invasive Cervical Cancer indicates a lack of access to routine cervical cancer screening. Papanicolaou (Pap) tests are highly reliable in identifying preinvasive cervical cancer; this test is a routine and relatively inexpensive part of obstetric and gynecologic care, prenatal, and primary care. Data on invasive cervical cancer are obtained from the tumor registry and hospital discharge data bases. If data are obtained from hospital discharge data, ICD-9 codes are combined with procedure codes to ensure that the cases are invasive cervical cancer and not earlier stages.

- Low Birth Weight is used to examine access to prenatal care among women, since a strong relationship exists between adequate prenatal care and the prevention of low birth weight. Higher than expected rates of low birth weight infants among certain population groups may indicate a lack of access to prenatal care. Low birth weight is defined in two ways:

infants weighing less than 2,500 grams and infants weighing less than 1,500 grams. These data are obtained from birth certificates.

- Tuberculosis tests are a routine part of primary care checkups in some states. People who test positive on a tuberculosis test are treated with a drug regimen so that the tuberculosis does not become active. Therefore, cases of active tuberculosis should not occur if individuals have access to primary health care. Data on tuberculosis are obtained from local health departments.

- Uncontrolled Diabetes is used to measure a lack of ongoing patient management. Diabetes can be controlled through proper patient management and requires an ongoing relationship with the health care system. Uncontrolled diabetes includes ketoacidosis, hyperosmolar coma, and gangrene with diabetes; all these conditions are measured using hospital discharge data.

- Uncontrolled Hypertension is another measure of access to ongoing primary care. Primary care patient management is essential in detecting and controlling hypertension since the proper management of hypertension requires careful and long-term follow up. Uncontrolled hypertension includes hypertensive encephalopathy, stroke or heart failure resulting from hypertension and hospital admissions for malignant hypertension. Data on uncontrolled hypertension are obtained from hospital discharge summaries.

For adult conditions, data were collected by age to permit examination of particular age groups, such as the middle-aged or elderly. This permits identification of high rates of events for particular groups of adults.

Once the events were selected, they were specifically defined to assure that the measurement of the event corresponded to the concept being tested. There were two problems in defining the events. First, we had to assure enough cases to identify differences in total rates of events and among population subgroups. One strategy for guaranteeing enough cases of events was to use multiple years of data. Another strategy was to combine events. For example, we combined measles, mumps, polio, and tetanus into one event indicating barriers to immunizations in order to ensure enough cases.

A second problem was specifying the event carefully enough so that practice patterns did not influence the rates of events. This involved defining the stages of the event to ensure that physicians presented with the stages of the conditions would uniformly hospitalize the patients. For example, cervical cancer may be treated on an outpatient basis in some stages; therefore, the stages defining invasive cervical cancer had to be so advanced that virtually all providers would hospitalize the person. Often several iterations were required to adequately define the events. The ICD-9 codes used are found in Appendix B.

B. INITIAL METHOD TO BE TESTED

This section summarizes the sentinel event method.

1. Process for Identifying Underserved Areas or Population Groups

Identifying geographic areas or population groups as potentially underserved involves calculating the relative rate of sentinel events among different areas and/or population groups. An area or population group with significantly higher rates of several sentinel events than other areas or population groups is identified as potentially underserved.

This comparison of rates avoids the problem of the occasional appearance of some events even among populations with good access to care. In practice, even with good medical care available, some cases will be observed. These may occur because of failure by patients to seek care in the face of symptoms, patient noncompliance with treatment, failure to detect the condition, and failure in treatment, such as measles resulting from immunization failure. Therefore, a relative comparison of rates of sentinel events permits a surer identification of areas or population groups with higher than expected rates of sentinel events.

The comparison requires calculation of a relative risk ratio, or the rate of a sentinel event in one area or population group divided by the rate of the sentinel event in another area or population group. For example:

$$\frac{\text{Incidence of measles in West Baltimore}}{\text{Incidence of measles in Baltimore MSA}} = \text{Relative Risk of Measles in West Baltimore}$$

Relative risk may compare the rate for each zip code in an area to the rate for the overall area or to compare the rate in certain areas, such as high poverty zip codes, to other areas, such as low poverty zip codes. If there is an access problem in both the small area and comparison populations, a relative risk ratio of one may reflect the choice of the comparison group. Therefore, in choosing the comparison group, it was important to draw from a broad socioeconomic base.

The above equation first required calculating the incidence or admission rate for each event in each area or population group. An incidence rate is the rate of occurrence of an event in the community. For example:

$$\frac{\text{Cases of Measles in West Baltimore}}{\text{Children ages 1-14 in West Baltimore}} = \text{Incidence of Measles in West Baltimore}$$

From the incidence rates, we calculated the relative risk ratio between two groups. A relative risk ratio of 1.0 represents no difference between the two groups. A relative risk ratio greater than 1.0 indicates that one population has a greater chance of having the event than the other population. For example, a relative risk ratio of 1.5

indicates that a population has a 50 percent greater risk of having the event than the other population.

These ratios raise the question, how much is too much? Does a ratio of 1.5 indicate a significant problem, or should the number be 1.1, or 3.0? Clinical significance and not statistical significance was used as the criterion for judging whether an area has too much of a sentinel event. Measures of statistical significance were not necessary in this analysis since we used the entire population of an area and not a sample of the area. Judgments of clinical significance were made using specific thresholds for each event. These thresholds of clinical significance were determined in consultation with the Advisory Committee and are shown in Table 2.1. They should be used as guidelines for determining clinical significance but should not be taken as absolutes. The thresholds can be increased or decreased and the results compared to determine whether the conclusions change as the thresholds change.

Thresholds were determined separately for each event. This determination depended upon how rare the event was and whether the rate of the event was influenced by confounding variables, such as race and socioeconomic status. The rarer the event, the lower the relative risk ratio needed to consider an area at risk. In reality some events, such as rheumatic fever, are rare and an area with any case is considered at risk; while other events, such as uncontrolled diabetes, occur more frequently and require a greater difference for the area to be considered at risk.

As shown in Table 2.1, for those events where the underlying condition is higher in certain populations, such as low income and minority groups, the thresholds are higher. This reflects an expectation that we will observe more of the underlying conditions in certain populations, but that above a certain level factors other than race and income explain the higher rate. For example, Black males are more likely to have hypertension than is the population as a whole. They

TABLE 2.1

RELATIVE RISK FOR EACH SENTINEL EVENT

THAT WOULD BE TAKEN AS INDICATIVE OF BARRIERS TO ACCESS

Sentinel Event	Relative Risk Greater Than
Infants	
• Dehydration	1.5
• Hyperbilirubinemia With Exchange Transfusion	1.2
Children	
• Asthma	2.0
• Hearing Loss From Otitis Media*	2.0
• Measles, Mumps, Polio, Tetanus	1.2
• Peritonitis	1.5
• Rheumatic Fever	1.2
Adults	
• Advanced Breast Cancer*	2.0
• Advanced Colorectal Cancer	2.0
• Invasive Cervical Cancer*	2.0
• Low Birth Weight*	1.5
• Tuberculosis	1.2
• Uncontrolled Diabetes*	2.0
• Uncontrolled Hypertension*	2.0

* Indicates events where some populations are more prone to the event or the underlying condition.

will thus have a somewhat higher incidence of uncontrolled hypertension. By setting the threshold at 2.0, we take this into account.

2. Data Sources

Two categories of data are required for computing incidence/admission rates: 1) the number of cases of the event, or the numerator of the incidence rate, and 2) the number of people at risk for the event, or the denominator of the incidence rate.

a. Number of Cases of Event (Numerators)

Defining the sentinel events was the most complex part of developing the initial method, requiring several iterations to assure that the event was specified correctly. For example, "uncontrolled diabetes" was defined as a combination of diagnostic codes, such as diabetic coma and gangrene from an infection.

Once the events were defined, we had to be sure enough cases would be observed to examine differences in areas and to analyze rates of events by age, race, and sex posed another problem. To do this we used multiple years of data to measure the sentinel events. A disadvantage of using multiple years is that combining several years of data can mask changes in access that might have occurred in any one year, but since the analysis requires a reasonable number of cases, this issue was less significant in comparison. In Baltimore data were aggregated from 1981 to 1985 and in Boston from 1982 to 1985.

Five data sources identified the number of cases of each event:

- Hospital discharge data were used to measure the hospital-based sentinel events, providing diagnosis and procedure codes. Maryland and Massachusetts each have sophisticated hospital discharge data bases. Both states are accustomed to responding to requests for customized data tapes from the discharge system, and requests were processed quickly and

efficiently. By providing a list of diagnosis codes (ICD-9 codes) which are aggregated to create sentinel events, and the zip codes of interest, we obtained a clean data tape with documentation. (The diagnosis codes are in Appendix B.)

We were unable to obtain hospital discharge data from North Carolina. The state is in the process of establishing a centralized hospital discharge data base, but it is not yet operational. We attempted to obtain the data required from the individual hospitals, but these hospitals did not have automated discharge abstracts.

- Data on reportable diseases were obtained from the health departments in Maryland, Massachusetts, and North Carolina. The geographic unit of analysis varied by state. For example, we obtained census tract data for Baltimore, zip code data outside Baltimore City, and town level data for Berkshire and Franklin Counties in Massachusetts. We provided the health department with table layouts specifying the data required. The data were received in hard copy to be entered into a computer. The Baltimore City Health Department did not have the staff available to produce the tables requested, so to obtain tuberculosis data, it was necessary to spend a day entering data from computer printouts.

- Birth certificate data are a source for low birth weight infants and the extent of prenatal care among women. In all three states outcome information, trimester of prenatal care, number of prenatal care visits, and demographic information were obtained. Data were obtained from Maryland, Massachusetts, and North Carolina by providing the health department with table layouts of the variable of interest. These data had to be entered into a computer for the incidence rates to be computed.

- Tumor registry data provides information on advanced stages of cancer. Massachusetts was the only state in our sample with a complete tumor registry. The Maryland tumor registry is in the early stages of development and lacks data from some hospitals in the Baltimore area, most notably Johns Hopkins. The Maryland tumor registry expects to have a complete reporting of hospitals in the next two years and will be a good source of cancer information. North Carolina does not have a tumor registry. (If tumor registry data are not available, hospital discharge data may be used to measure advanced cancers.)

- School hearing tests records were used to measure hearing loss from otitis media in Baltimore. The Baltimore City Health Department maintains hearing test records from all

the schools in the city. These records are not computerized and are discarded annually. Analysis of the hearing test records revealed that no follow-up information was provided, thereby making it difficult to distinguish hearing loss from otitis media from other types of hearing loss. We decided to drop this event from further study because the data were unreliable.

b. Population at-risk for Event (Denominator)

One of the challenges in testing the sentinel event method was determining the population at risk for the event. Ideally, one would measure the specific population at-risk for each event over the same time period as the number of cases. For example, to measure the incidence of uncontrolled hypertension, the ideal denominator would be the number of people in the area with hypertension. In a few cases we had the correct denominator. For example, the number for births in an area is the denominator for low birth weight. Since for other events these denominators are usually unavailable, we relied on proxy measures, most typically the entire population of the area or the adult or child population, depending on the condition. Where the actual population at risk was unknown, we used Census Bureau data as the population denominator. Table 2.2 shows the data source to measure the number of cases and the population denominator used for each sentinel event. We used two data sources to measure the denominator:

- Census Bureau data were used for most of the population denominators. These data were available on computer tape by zip code and in hard copy by census tract for every state. These data had demographic variables such as age, race, and sex. In addition, the income of the area was used to compare differences in sentinel events by income.
- Birth certificate data provided the number of births in an area to be used as the denominator for low birth weight. Data were also available on the age and race of the mother.

TABLE 2.2

SENTINEL EVENTS USED IN FIELD-TESTING

EVENTS	DATA SOURCE	DENOMINATOR
Infants		
Hyperbilirubinemia with exchange transfusion	Hospital discharge data	Infants:total and by race
Dehydration	Hospital discharge data	Infants:total and by race
Children		
Asthma	Hospital discharge data	Children age 1-14:total and by race
Hearing loss from otitis media	School hearing tests	Grades pre-k through ninth
Measles, Mumps, Polio, Tetanus	Public health department	Children age 1-14:total and by race
Peritonitis	Hospital discharge data	Children age 1-14 with appendicitis
Rheumatic Fever	Hospital discharge data	Children age 1-14:total and by race
Adults		
Advanced Breast Cancer	Tumor registry	Females:total and by age, race and stage
Advanced Colorectal Cancer	Hospital discharge data, tumor registry	Adults:total and by age, race and stage
Invasive Cervical Cancer	Hospital discharge data, tumor registry	Females:total and by age, race and stage
Low Birth Weight	Birth certificates	Births:total, by race, age of mother and prenatal care
Uncontrolled Diabetes	Hospital discharge data	Adults:total and by sex, age, and race
Uncontrolled Hypertension	Hospital discharge data	Adults:total and by sex, age, and race
Tuberculosis	Public health department	Area population:total, by sex and race

C. FIELD-TESTING THE METHOD

Once the initial method was designed, it had to be field-tested to judge its effectiveness and practicality. The field-testing addressed three questions:

- Does the sentinel event method identify possible areas of underservice?
- Can sentinel events be used to target resources to specific population groups?
- Is the method practical for use by policy makers and program managers?

1. Plan for Field-testing

To answer these questions, the event was field-tested in four sites. The original plan specified that community health centers would be responsible for field-testing the method and that the project team would supervise this effort. During the development of the method, the Advisory Committee suggested that instead the project team be responsible for testing and refining the method before it is used by organizations in the field. As a result, we assumed responsibility for testing the method at four sites.

The method was field-tested in two urban and two rural sites. The analysis for the second site was not started until the analysis for the first site had been completed, and the Advisory Committee had met to discuss the findings and refine the method. The criteria for selection were that the sites be 1) representative of both urban and rural areas; 2) varied in the availability of data; and 3) areas of well-established primary care associations who could assist with identifying data sources and later, with interpreting results. Using these criteria, we chose the following:

- **Urban areas**. We selected Baltimore and Boston as the urban areas for field-testing. In both cases, the surrounding suburbs were included in the analysis to ensure a broad socioeconomic base. Both Maryland and Massachusetts have centralized hospital discharge data bases and extensive public health reporting requirements.

- **Rural areas**. Berkshire and Franklin counties in Massachusetts and Halifax and Hertford counties in North Carolina were chosen after consultation with experienced observers in the two states. The two counties in each state have differing numbers of physicians and organized primary care centers and were perceived by individuals working in the states as having differing levels of access to health care. Exhibits 2.1 and 2.2 show the rural areas chosen for analysis.

  We wanted to determine how much more difficult it would be to test the method in a state without centralized hospital discharge data. North Carolina provided this opportunity. In contrast, Massachusetts has a sophisticated centralized hospital discharge data base that includes rural areas. Both states had the non-hospital data available. The county was used as the unit of analysis for rural areas because many of the data were not available on a zip code basis.

Before starting the data collection in Baltimore and Boston, we convened a local work group to assist us in identifying data sources and specifying the potential pitfalls in using the data. The work group was composed of state and local health department officials, data analysts, and others working on primary care issues. This proved helpful in obtaining the data in a timely fashion.

Throughout the study we conducted telephone interviews of program managers, data analysts, and others knowledgeable about access to care. The telephone interviews assisted us in selecting the sentinel events and in interpreting the findings. They provided a "reality test" to assure that those events identified from the literature are also good events in practice. They also assisted in interpreting the findings by reviewing the areas identified by the sentinel event method and determining whether they are underserved.

EXHIBIT 2.1

RURAL COUNTIES TESTED IN MASSACHUSETTS

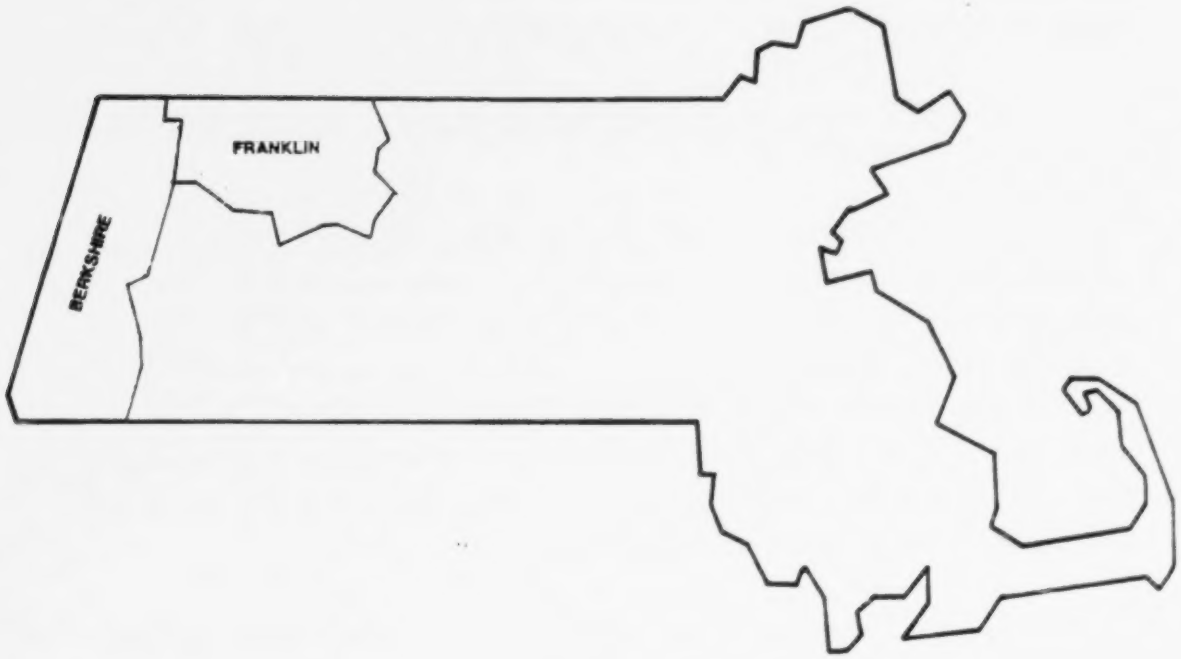
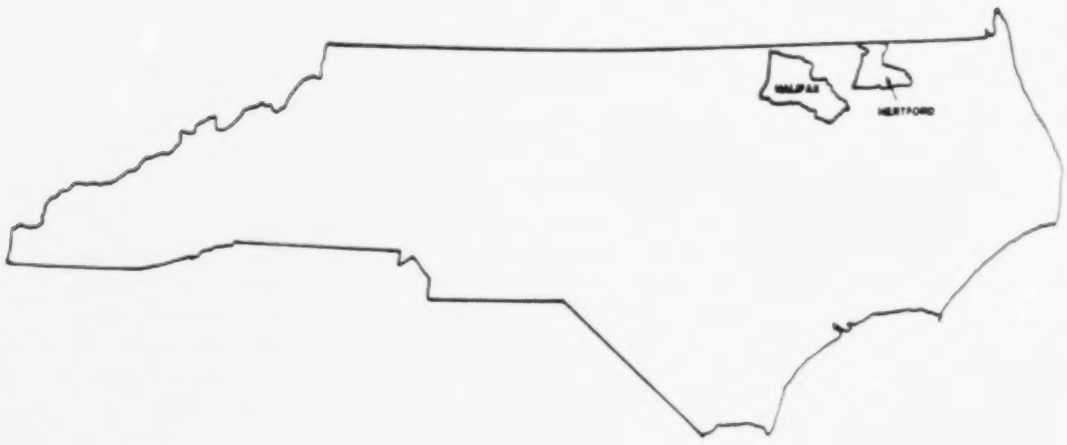


EXHIBIT 2.2

RURAL COUNTIES TESTED IN NORTH CAROLINA



Once these areas were chosen, we began field-testing the method to answer the study questions. The section below describes the process for answering the study questions. The findings are found in Chapter Three.

a. Does the Sentinel Event Method Identify Possible Areas of Underservice?

To answer this question in urban areas, we computed the incidence rate of each sentinel event by zip code, the most available geographic unit below the county level, especially for hospital discharge data. These incidence rates were divided by the incidence rate for the overall area to compute a relative risk ratio for each event by zip code. Areas with relative risk ratios above the threshold on two or more events were identified as "high sentinel event" areas and considered to be potentially underserved.

In rural areas we computed the incidence rate of each sentinel event by county. A relative risk ratio was then calculated by dividing the incidence rate of the county with fewer resources by the incidence rate of the county with greater resources.

To verify whether the method identified areas that are indeed underserved or merely identified areas at random, we compared the areas identified by the sentinel event method to those identified by other measures of underservice. These other measures include HMSA and MUA designated areas, population-to-FTE/physician ratios, and possible surrogates of underservice, such as income and insurance:

- **HMSA and MUA Areas**. Comparing HMSA and MUA areas to "high sentinel event" areas required converting census tracts to zip codes. Both HMSA and MUA areas are designated by census tract, while the sentinel event areas are identified by zip code. In Boston, the health department had matched zip codes and census tracts. However, in Baltimore, where no match existed, we converted census tracts to zip codes by placing the census tract in the zip code containing the

majority of the census tract. We then compared the HMSA an MUA zip codes to the "high sentinel event" zip codes to see if the two measures track.

- **Population-to-FTE Physician Ratio**. We also compared the "high sentinel event" areas to the population-to-FTE/physician ratio by zip code. This enabled comparison of the sentinel event areas to areas that may be eligible for HMSA designation but never submitted an application.

- **Income**. The sentinel event areas were also compared to areas with high rates of poverty to determine the correlation between income (from Census data) and the rate of sentinel events. Unfortunately, no individual patient income information is available. Instead, the average income or rate of poverty of a zip code was used as a proxy for income or poverty for the individuals in the zip code. Therefore, while we may know that a high rate of a specific sentinel event occurs in a low income zip code, we do not know that the individuals with the sentinel events are the low income individuals. The more homogeneity there is within a zip code, the greater the ability to generalize from the zip code as a whole to the individuals in the zip code.

- **Insurance**. We were also interested in testing whether high rates of sentinel events are associated with a lack of health insurance. To compare rates of sentinel events between the insured and the uninsured, we obtained the numerators by payer category. (Obtaining the numerators is only possible with hospital discharge data because data are reported by expected source of payment.) These data include Medicare, Medicaid, Blue Cross, other commercial insurance and "self-pay." In this analysis "self-pay"[1] was used as a proxy for the uninsured in low income areas.

  We obtained denominators for the Medicare and Medicaid populations and planned to use proxies for the self pay and privately insured populations. These proxies would make assumptions about the number of self-pay and privately insured persons in the population based on income.

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[1] Using expected source of payment may underestimate the Medicaid population and overestimate the self-pay because people who enter the hospital as self-pay may become enrolled in Medicaid upon leaving the hospital. This is unlikely to affect the results, because those who become eligible for Medicaid when they are hospitalized were probably uninsured during the early stages of the condition.

b. Can the Sentinel Event Method Identify Population Subgroups at Risk?

We also looked at rates of sentinel events by age, race, and sex to determine whether some population subgroups are at greater risk for certain sentinel events than others. Population groups were examined in two ways. First, for high sentinel event areas, we looked at the specific events to determine whether they cluster in certain age groups. For example, a zip code with high rates of four events, all of which affect children, may have a health status problem for children, but not for other population groups. Second, we calculated the age, race, and sex specific incidence/admission rates and compared them to the same population groups in other areas and to other population groups within the same area. For example, we compared the rate of sentinel events among minorities and non-minorities in the same areas and the rate of events among the elderly in one area to the rate among the elderly in another area. The relative risk was computed to determine the population groups at risk for the sentinel events.

c. Is the Method Practical for Use by Policy Makers and Program Managers?

To assess the practicality of the method, we examined the quality and availability of data, the resources required to use the method, and whether it is easy to understand and administer. The findings on the practicality of the method are in Chapter Four. How we assessed the practicality is described below:

- **Data availability**. We kept close track of the process for obtaining the data. In particular, we monitored the difficulty in obtaining a particular data source, the time between the submission of the data request and the receipt of the data, and which data sources seemed to work best in analyzing the sentinel events. We also assessed whether it makes a difference to receive the data on computer tape or hard copy.

- **Resources**. We monitored the computer and personnel resources required to use the method. This involved monitoring the computer costs and labor time used in testing the method, and also considering alternative computer packages and personnel that could be used.

- **Easy to understand and administer**. We closely examined the process used to test the sentinel event method and looked for easier, more efficient ways to conduct the analysis. The sequential analysis of the test sites allowed review of the process in the first site and simplify it for the next three sites.

2. Modifications to the Plan for Field-testing

During the course of testing the sentinel event method, we made several modifications to reflect new knowledge gained from the field-testing at a prior site and to address problems arising in testing the method.

a. Field-testing Sites and Process

We made two modifications to the field testing. First, the North Carolina field testing excluded hospital discharge data. One reason for choosing North Carolina as a site was to test the method in a state without a centralized hospital discharge data base. Obtaining these data from individual hospitals was more difficult than anticipated; some of the hospitals did not have automated hospital discharge summaries. Therefore, it was infeasible to analyze these data. North Carolina is in the process of creating a centralized hospital discharge data base and would be a good state to conduct this analysis in three-five years.

The second modification in the field-testing was the deletion of some events from further study. After completing the Baltimore analysis we dropped hearing loss from otitis media as a sentinel event because of the lack of good data to measure hearing loss. Using school hearing test records, it was impossible to distinguish hearing loss from

otitis media from other reasons children fail hearing tests. Upon completing the Boston analysis, we dropped advanced colorectal cancer, hyperbilirubinemia with exchange transfusion, and peritonitis from further study. Reasons include a finding of little relationship between access to primary care and the occurrence of advanced colorectal cancer and peritonitis, as well as the observation of too few cases of hyperbilirubinemia with exchange transfusion.

b. Identifying Underserved Areas

In testing the method to identify areas of potential underservice, we made two modifications. First, we could not obtain data on physician FTEs by zip code for areas outside Baltimore City or for Massachusetts. Therefore, for those areas where we did not have HMSA or MUA data, we could not examine the number of physicians. Second, obtaining population denominators for insurance status proved to be a problem. Unless the area had conducted a household survey as in Boston and had data on the number of uninsured by zip code we could not examine insurance status.

c. Targeting Specific Population Groups

In testing the method to identify specific population groups at risk, we were limited by the availability of data on demographic characteristics. For example, the Massachusetts hospital discharge data had incomplete information on race. Tuberculosis data from Boston also excluded race information. All other data sources included age, race, and sex information.

With this description of the process of testing the method, we now turn to the findings. Chapter Three presents the findings on the effectiveness of the method. Chapter Four discusses the practicality of the method.

CHAPTER THREE
EFFECTIVENESS OF THE SENTINEL EVENT METHOD

The development of a method to incorporate health status into measures of medical underservice could augment the current reliance on resource and utilization measures and create a more sophisticated method for identifying underservice. The development and field testing of a set of sentinel health events as measures of underservice were intended to contribute to the evaluation of such methods. In this chapter we examine two aspects of the potential use of the sentinel event method:

- Does the sentinel event method identify possible areas of underservice?
- Can sentinel events be used to target resources to specific at-risk population groups?

The results of the field-testing are encouraging; the answers to both these questions proved to be a qualified "yes." The method did identify areas with apparent health status problems that could then be further studied to confirm whether and what barriers existed to obtaining appropriate primary care, and it has potential to be used as a planning tool to help target resources and services to specific population groups.

This chapter describes the effectiveness of the method, drawing from its application in Maryland, Massachusetts, and North Carolina. Section A describes how the method is effective in identifying possible areas of underservice. Section B discusses the potential of the method for targeting resources to specific population groups.

A. IDENTIFYING POSSIBLE AREAS OF UNDERSERVICE

In assessing the effectiveness of the sentinel event method as a tool for identifying underserved areas, three criteria were used:

- The sentinel event method must not identify areas at random.
- The method must identify areas which match areas designated by other measures of underservice.
- The method must identify areas which, while not identified by other measures, appear to be underserved when examined in other ways.

1. Sentinel Event Method Must Not Identify Areas at Random

To be considered effective, the method had to identify areas that appear to have barriers to primary care. The first test is that high rates of sentinel events should not occur at random, the result of statistical chance. Instead, the areas with high rates should be those that prior experience and information suggest are underserved.

Several of the original events failed this test. They appeared during analysis to identify areas at random or not be associated with underservice:

- Advanced colorectal cancer. This event appeared to identify areas at random. Both underserved and adequately served areas and rich and poor areas were identified as being at-risk for advanced colorectal cancer. One explanation may be that the introduction of screening for colorectal cancer into routine primary care is a relatively recent phenomenon, largely brought about by the publicity associated with President Reagan's experience with the disease. It appears that neither low income nor affluent populations were previously being routinely screened for colorectal cancer. Thus, differential access to screening for colorectal cancer was not measured with data from 1981 to 1985. In future years advanced colorectal cancer may be a good indicator of barriers to primary care.

- **Hearing loss from otitis media**. The data for this event proved to be unreliable, preventing us from drawing conclusions about access to primary care in those areas with different rates of this event.

- **Hyperbilirubinemia with exchange transfusion**. This event had too few cases to draw conclusions about the areas with high rates of events. There were not enough cases to determine whether the method had actually targeted underserved areas or merely surfaced geographic areas at random.

- **Peritonitis**. This event was found equally in high-income and low-income areas, indicating that it may not be a good measure of access to primary care.

These events were subsequently deleted from the analysis. Table 3.1 shows the relative risk ratio for the final set of sentinel events. For those events that remain, the effectiveness of the sentinel event method was judged separately for urban and rural areas, with varied results. The method proved to be more effective in urban areas than rural areas, since the findings in rural areas were inconclusive.

a. Areas Identified in Urban Areas

Areas found to have significantly high rates of sentinel events in Baltimore and Boston appear to be underserved and not to occur at random. They are areas that we would expect to identify, based on what is known about the characteristics of underserved populations. This is illustrated in Appendix A, which presents a matrix of sentinel events in Baltimore and Boston by zip code ranked by their Index of Medical Underservice (IMU) score, where available, and the percent of population with incomes below 150 percent of poverty. Those areas with rates of two or more sentinel events above the relative risk threshold were considered high sentinel event areas. Exhibits 3.1 and 3.2 map the areas identified by the sentinel event method in Baltimore and Boston. Most areas with high rates of sentinel events share one or more of the following characteristics:

TABLE 3.1

RELATIVE RISK FOR EACH SENTINEL EVENT

THAT WOULD BE TAKEN AS INDICATIVE OF BARRIERS TO ACCESS

Sentinel Event	Relative Risk Greater Than
Infants	
• Dehydration	1.5
Children	
• Asthma	2.0
• Measles, Mumps, Polio, Tetanus	1.2
• Rheumatic Fever	1.2
Adults	
• Advanced Breast Cancer	2.0
• Invasive Cervical Cancer	2.0
• Low Birth Weight	1.5
• Tuberculosis	1.2
• Uncontrolled Diabetes	2.0
• Uncontrolled Hypertension	2.0

EXHIBIT 3.1

AREAS IN BALTIMORE WITH HIGH INCIDENCE OF SENTINEL EVENTS

Lewin and Associates incorporated

EXHIBIT 3.2

AREAS IN BOSTON WITH HIGH INCIDENCE OF SENTINEL EVENTS

- **Location in cities**. The vast majority of the areas found to have high rates of sentinel health events are located in the cities of Baltimore and Boston and not in their suburbs. Based on what is known about indicators of medical underservice, this is not surprising. Medically underserved populations tend to be low income, members of minority groups, and to be uninsured or underinsured. These populations are generally overly represented in cities.

- **High poverty**. We know that many of the sentinel events occur in greater numbers among low-income populations. These populations are both more prone to many of the underlying conditions that lead to these events, and they also tend to be underserved. The analysis found that the majority of areas identified with high rates of sentinel events are located in high poverty areas. Thirteen areas (61 percent) of the high sentinel event areas in Baltimore and 10 areas (49 percent) in Boston had more than 30 percent of their population below 150 percent of poverty.

- **Large number of minorities**. Minorities are also overrepresented among underserved populations and among the groups with high rates of sentinel events. Nine (40 percent) of the areas identified by the sentinel event method in Baltimore and 6 areas (30 percent) in Boston have greater than one-third of their population composed of minorities.

- **High rate of uninsurance**. High sentinel event areas are also composed of higher than average rates of people who lack health insurance. The four neighborhoods in Boston with the highest uninsured population (East Boston, Jamaica Plain, North Dorchester, and Roxbury) were also identified as problem areas by the sentinel event method.

In subsequent sections we will show that the sentinel event method identifies additional areas that are neither high poverty, largely minority, nor largely uninsured. Other information about these areas suggests that underservice might be a problem in many of them. While the method may identify some areas in which underservice is not a problem, it is clear that the method does not simply spot areas at random.

b. Areas Identified in Rural Areas

The results in Massachusetts and North Carolina showed that rural areas have higher rates of some events than urban areas, but differences in rates between the rural areas were not observed. The analysis in rural areas was intended to determine whether the rate of events varied between rural counties with differing levels of health care resources.

In selecting counties for comparison, we examined the population-to-physician ratio and the presence of an organized primary care center, such as a community health center. A high resource area had a high population-to-physician ratio and one or more organized primary care centers, while a low resource area had a low population-to-physician ratio and no organized primary care center. In Massachusetts we expected to find a higher rate of sentinel events in Franklin county than in Berkshire county because Franklin County has fewer physicians and primary care centers than Berkshire County. Berkshire County has one community health center and an increasing supply of physicians. These physicians are reportedly treating low-income populations. In Franklin County there are fewer resources, and those that exist are more dispersed. In North Carolina we anticipated a higher rate of sentinel events in Hertford County than in Halifax County. Poverty rates and infant mortality rates are roughly comparable in these two counties, but Halifax has a community health center. We were interested in learning whether the presence of the community health center resulted in lower rates of sentinel events in Halifax County.

The results of these comparisons were inconclusive. Franklin County had a higher rate of asthma and invasive cervical cancer using tumor registry data than Berkshire County. However, Berkshire County had a higher rate of dehydration, rheumatic fever, and tuberculosis. For advanced breast cancer, low birth weight, and uncontrolled diabetes and hypertension, there was no difference between the rate of events in

the two counties. These differences are shown in Table 3.2. As shown in Table 3.3, no difference was observed between Halifax and Hertford counties on any of the events.

We may not have captured real differences in health status in rural areas for several reasons. First, the level of resources in an area may not be an adequate measure of access to primary care. Other factors, such as transportation and financial resources, may contribute to access in rural areas as much or more than the availability of health care resources. More extensive analysis than was possible within the scope of this project might be necessary to accurately characterize the extent of health resources in rural areas.

Second, rural areas may generally have higher rates of sentinel events, thereby narrowing any differences between rural areas. By comparing rural areas in Massachusetts to the Boston area, we found that rural areas are indeed at greater risk for some of the sentinel events. For example, rural populations are three times as likely to have rheumatic fever and twice as likely to have infant dehydration as urban populations. This suggests that rural populations face greater barriers to primary care than do urban populations.

Third, the level of resources in the areas chosen for comparison may not vary enough to produce different rates of sentinel events. We chose rural counties with varying levels of resources, expecting to find greater rates of sentinel events in the county with fewer resources. Without conducting a survey of health care resources in both counties, we cannot be sure that these counties actually have significantly fewer resources to permit detection of differences in the rate of sentinel events.

A fourth possible explanation for the inconclusive findings in rural areas is that underreporting of sentinel events may exist. Ironically, a lack of access to care may mean that sentinel events may

TABLE 3.2

Incidence of Sentinel Events in Berkshire and Franklin Counties

Total Population

SENTINEL EVENTS	FRANKLIN COUNTY INCIDENCE (PER 1,000)	BERKSHIRE COUNTY INCIDENCE (PER 1,000)	RELATIVE RISK FRANKLIN/BERKSHIRE
Dehydration	86.54	171.51	.50
Asthma	.13	.07	1.86
Measles, mumps, polio, tetanus	.13	0.00	
Rheumatic fever	.07	.11	.64
Advanced breast cancer	1.92	2.16	.89
Advanced cervical cancer 1*	.26	.42	.62
Advanced cervical cancer 2**	.26	.16	1.63
Low birth weight (<2500g)	.06	.06	1.0
Low birth weight (<1500g)	.01	.01	1.0
Tuberculosis	.09	.13	.69
Uncontrolled diabetes	4.56	4.72	.96
Uncontrolled hypertension	2.59	3.25	.80

* Hospital discharge data.
** Tumor registry data.

TABLE 3.3

Incidence of Sentinel Events in Halifax and Hertford Counties

Total Population

SENTINEL EVENTS	HALIFAX COUNTY INCIDENCE (PER 1,000)	HERTFORD COUNTY INCIDENCE (PER 1,000)	RELATIVE RISK FRANKLIN/BERKSHIRE
Measles, mumps, polio, tetanus	0	0	
Low birth weight (<2500g)	95.76	90.06	.94
Low birth weight (<1500g)	16.57	18.79	1.13
Tuberculosis	4.39	4.76	1.08

fail to be reported even though they are occurring. For example, people may die of uncontrolled diabetes or invasive cervical cancer before getting to a hospital; therefore, the event will not have been recorded into the available data bases. As a result, the apparent rate of some sentinel events may appear lower than is actually the case.

Finally, the county may be too large an area of analysis for using sentinel events. Problem areas within counties may be masked by results for the county overall. For example, population groups with low rates of sentinel events may be large enough to inhibit the detection of subpopulations with high rates of these events.

Further analysis is required to determine the effectiveness of the sentinel event method in rural areas. Because the results from the rural analysis were inconclusive, the remainder of this chapter will focus the sentinel event analysis in urban areas.

2. The Method Must Identify Areas which Match Areas Designated by Other Measures of Underservice

If the sentinel event method is effective, it should identify areas identified as underserved by other measures. To test this, we compared the method to two other types of measures:

- Methods used by the Public Health Service to measure underservice.
- Income and insurance status, which have been suggested as possible surrogates of underservice, because they are associated with access to care.

The match of the sentinel event method with these other approaches is described below.

a. Methods Used by the Public Health Service to Measure Underservice

The current measures used by the federal government to measure underservice include Health Manpower Shortage Areas (HMSA), Medically Underserved Areas (MUA), and the Need/Demand Assessment. We compared the areas identified by the sentinel event method to areas identified by the HMSA and MUA methods. Exhibits 3.3 and 3.4 map the HMSA, "HMSA eligible," and MUA areas in Baltimore and Boston. We did not compare the Need/Demand Assessment to the sentinel event method, since the Need/Demand Assessment in its present form cannot be aggregated to identify underserved areas.[1]

As shown in Tables 3.4 and 3.5, the sentinel event method surfaces many of the HMSA, "HMSA eligible," and MUA areas. In Baltimore 6 of the areas identified with sentinel events were also HMSAs, and 13 of the areas were also MUAs. In Boston 13 of the areas identified by sentinel events were HMSAs and MUAs. As shown, neither HMSA nor MUA alone match the sentinel event areas. Instead, it takes the combination of the HMSA, "HMSA eligible" and MUA measures to identify many of the areas found with the sentinel event method.

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[1] In Baltimore, the HMSA designated areas do not fully represent the areas eligible for HMSA designation. This is often because areas that do not expect to receive National Health Service Corps physicians often do not submit HMSA applications even if they are eligible. To address this problem, we derived "HMSA eligible areas" for Baltimore using data on the number of FTE physicians in each zip code. A "HMSA eligible" area is defined as having a population-to-physician ratio of greater than or equal to 3,500 to 1. "HMSA eligible" areas were not calculated for Boston because based upon the overlap between HMSA and MUA areas and discussions with program manager, underdesignation of HMSA eligible areas did not appear to be a problem.

In Baltimore all the areas identified as HMSA, HMSA eligible, or MUA were also identified using the sentinel event method. However, in Boston, three areas (Back Bay, Field's Corner, and North End) were identified as HMSAs and MUAs but not as sentinel event areas. Those knowledgeable about health care in these comunities have suggested reasons why they might not be identified as sentinel event areas:

- Back Bay has become gentrified in recent years and many of the populations with health status problems have moved out. This may explain why we did not observe high rates of sentinel events in this area.

- Field's Corner has received adequate resources to serve its population. According to primary care experts in Boston, the area has four strong community health centers and is aggressive about getting people into primary care systems. These centers provide alternatives to hospital emergency rooms. As a result people are receiving continuous primary care instead of the episodic care often available to inner city populations. In addition, the social service system in this area seems to work well, providing additional support and case management. The limited rates of sentinel events observed in this area may reflect the success of these efforts.

- North End has become gentrified in recent years. It is an old established neighborhood near Massachusetts General Hospital. There is a well-established community health center that serves the low- and moderate-income populations.

b. Possible Surrogates for Underservice

Because low income and lack of health insurance are associated with problems in obtaining health care, it has been proposed that these factors be used as surrogate measures for underservice. We therefore examined the extent to which high sentinel event areas were areas of low income or high uninsurance and whether these alternate measures by themselves would identify areas of underservice.

EXHIBIT 3.3

HMSA, MUA AND OR "HMSA ELIGIBLE" AREAS IN BALTIMORE

Lewin and Associates incorporated

EXHIBIT 3.4

HMSA AND/OR MUA AREAS IN BOSTON

TABLE 3.4

Comparison of Sentinel Event Methodology with Other Measures of Medical Underservice

Baltimore

ZIP CODE	SENTINEL EVENT[1]	HMSA	HMSA ELIGIBLE[2]	MUA
21217	X		X	X
21223	X	X	X	X
21216	X		X	X
21201	X			X
21218	X	X		X
21211	X	X		X
21230	X		X	X
21202	X			X
21213	X		X	X
21215	X	X		X
21205	X		X	X
21231	X		X	X
21224	X	X	X	X
21225	X	X	X	
21226	X			
21237	X			
21212	X			
21207	X			
21214	X		X	

1 A sentinel event zip code is one that is above the relative risk threshold on at least two events.

2 A HMSA eligible zip code is one with a population-to-physician ratio of 3,500:1 or greater.

TABLE 3.5

Comparison of Sentinel Event Methodology with Other Measures of Medical Underservice

Boston

NEIGHBORHOOD	ZIP CODE	SENTINEL EVENT	HMSA	MUA
North End	02113		X	X
Back Bay	02116		X	X
South End	02118	X	X	X
Roxbury	02119	X	X	X
Grove Hall	02121	X	X	X
Fields Corner	02122		X	X
Codman Square	02124	X	X	X
Uphams Corner	02125	X	X	X
Mattapan	02126	X	X	X
South Boston	02127	X		
East Boston	02128	X	X	X
Jamaica Plain	02130	X	X	X
Roslindale	02132	X		
Allston	02134	X	X	X
Brighton	02135	X	X	X
Hyde Park	02135	X		
Harvard Square	02136	X		
Union Square	02143	X		

1 A sentinel event zip code is one that is above the relative risk threshold on at least two events.

Income. Many of the sentinel event areas are high poverty areas. However, some high poverty areas are not sentinel event areas, and some sentinel event areas are not high poverty areas.

As expected, the risk of individual sentinel events is greater in high poverty areas than in low poverty areas. This finding is consistent with the research on the incidence of these events. According to this research, the poor are at greater risk for advanced breast cancer, dehydration, invasive cervical cancer, low birth weight, uncontrolled diabetes, uncontrolled hypertension, and tuberculosis than the non-poor. An examination of the rate of events in high poverty compared to low poverty areas in Baltimore and Boston largely confirms this research. High poverty areas had at least twice the risk of dehydration, measles, invasive cervical cancer, low birth weight, uncontrolled diabetes, uncontrolled hypertension, and tuberculosis. (See Tables 3.6 and 3.7.)

Low income women appear less likely to be screened for breast cancer and cervical cancer and less likely to receive follow-up care than middle- and high-income women. In Baltimore and Boston individuals in high poverty areas are at greater risk of being diagnosed with advanced stages of cancer than individuals in low poverty areas. This finding is supported by results from the analysis of tumor registry data in Boston which show that cancers are diagnosed at advanced stages more often in high poverty areas and at early stages more often in low poverty areas.

Most of the areas identified by the sentinel event method are high poverty. However, the method did identify areas that appear to be underserved but are not high poverty areas. In Baltimore these are zip codes 21207, 21212, 21214, and 21237; in Boston these are Harvard Square, Hyde Park, Roslindale, and Union Square. This suggests that if only poverty is used as a surrogate, some underserved areas might be missed.

TABLE 3.6

Incidence of Sentinel Health Events in High Poverty Compared to Low Poverty Areas

Baltimore

SENTINEL EVENT	HIGH POVERTY[1] INCIDENCE (Per 1,000)	LOW POVERTY[2] INCIDENCE (Per 1,000)	RELATIVE RISK
Dehydration	3.15	1.50	2.10
Measles, mumps, polio, tetanus	.49	.21	2.33
Rheumatic fever	.03	0	--
Invasive cervical cancer	2.47	.56	4.41
Low birth weight	128.60	55.68	2.31
Tuberculosis	1.85	.33	5.61
Uncontrolled diabetes	13.53	3.89	3.48
Uncontrolled hypertension	18.76	7.26	2.58

1 Areas are high poverty if more than 40 percent of the population is below 150 percent of poverty.

2 Areas are low poverty areas if less than 6 percent of population is below 150 percent of poverty.

TABLE 3.7

Comparison of Sentinel Events in High Poverty Areas
to Low Poverty Areas

Boston Area

Total Population

SENTINEL EVENT	HIGH POVERTY[1] INCIDENCE (Per 1,000)	LOW POVERTY[2] INCIDENCE (Per 1,000)	RELATIVE RISK
Dehydration	163.76	24.52	6.68
Asthma	1.86	.18	10.33
Measles, mumps, polio, tetanus	2.30	.36	6.39
Rheumatic fever	0.18	0.09	1.96
Advanced breast cancer	1.24	1.97	0.63
Invasive cervical cancer (1)*	1.38	0.32	4.32
Invasive cervical cancer(2)**	.27	.13	2.08
Low birth weight (<2,500g)	107.25	42.90	2.50
Low birth weight (<1,500g)	21.56	7.81	2.76
Tuberculosis	1.02	.14	7.29
Uncontrolled diabetes	6.12	3.10	0.97
Uncontrolled hypertension	3.09	1.66	1.86

* Hospital discharge data.

** Tumor registry data.

1 Areas are high poverty if more than 35 percent of the population is below 150 percent of poverty.

2 Areas are low poverty if less than 6 percent of the population is below 150 percent of poverty.

Insurance status. In Boston where a survey of insurance status by zip code was available we found that the uninsured have higher rates of sentinel health events than privately insured populations. They are 1.5 times as likely as the privately insured to have dehydration, invasive cervical cancer, and uncontrolled hypertension. However, the highest rates of sentinel health events were found among the Medicaid population. (See Table 3.8.) The Medicaid population was over twice as likely as the privately insured to have dehydration, invasive cervical cancer, and uncontrolled hypertension. It is important to note that these results are specific to Boston and results for the Medicaid population in other cities may vary. This suggests that, while the uninsured appear to be underserved, some populations identified as insured may also be underserved for primary care, perhaps because they have difficulty attaining care as clients of these programs, or perhaps because they become eligible for an insurance program like Medicaid only as a result of a serious illness in part resulting from lack of primary care.

Another explanation for this finding is that some physician do not accept Medicaid recipients, forcing the patients to rely on emergency rooms or hospital outpatient departments for their care. As such, they may be receiving episodic care rather than primary care case management. Although we do not have statistical evidence that these factors are occurring in Baltimore and Boston, national studies have shown that these barriers to appropriate care exist among Medicaid recipients. In addition, household surveys have shown that the Medicaid population is heavily dependent upon emergency rooms for their health care.

Another explanation for the greater risk among the Medicaid population may be the demographic composition of that population compared to the uninsured and the privately insured. The Medicaid population has a higher proportion of women and children than the other groups. Unfortunately, we could not examine the effect of demographic composition on the findings because data on insurance status by age and

TABLE 3.8

RATES OF SENTINEL HEALTH EVENTS BY
INSURANCE STATUS IN SOME BOSTON NEIGHBORHOODS

SENTINEL EVENTS	PRIVATE INSURED	SELF PAY		MEDICAID	
	Incidence	Incidence	Relative Risk Self Pay/ Privately Insured	Incidence	Relative Risk Medicaid Privately Insured
Dehydration	.65	1.26	1.94	5.10	7.85
Asthma	.13	.12	.92	.92	7.08
Invasive Cervical Cancer	.30	.46	1.53	1.12	3.73
Uncontrolled Diabetes	2.79	3.17	1.14	5.79	2.08
Uncontrolled Hypertension	.91	1.40	1.54	2.34	2.57

sex were not available. Finally, because the Medicaid population has higher rates of chronic conditions, the higher rates of sentinel events may result, in part, from readmission to the hospital.

Based on the analysis of insurance status in Boston, using lack of insurance alone to target underserved populations is not sufficient. As shown, identifying the uninsured as underserved would miss those insured populations with barriers to access to appropriate primary care.

3. The Method Identifies Areas which, while not Identified by Other Measures, Appear to Be Underserved when Examined in Other Ways

If the sentinel event method identifies underserved areas that are not picked up by other measures, then the method could be a promising new way of identifying underserved areas. This might indicate that health status measures provide a better indicator of underservice than resource or utilization measures. If, however, the method is shown only to confirm existing methods, further development and verification may not be justified.

Analysis of the sentinel event method in Baltimore and Boston shows that the method does identify areas which appear to be underserved and are not found with existing methods. We examined these areas closely to determine whether they were actually underserved or whether the method had identified areas that are not underserved. This was done by conducting interviews with health planners and program managers in Baltimore and Boston to learn more why certain areas have high rates of sentinel events but are not found by other measures.

Four areas in Baltimore (zip codes 21207, 21212, 21226, and 21237) and five areas in Boston (South Boston, Harvard Square, Union Square, Roslindale, and Hyde Park) have high rates of sentinel events but are not found to be underserved by other measures. Exhibits 3.5 and 3.6 show these areas in Baltimore and Boston identified only by the

sentinel event method. A closer examination of these areas revealed that all the Baltimore and Boston areas appear to be underserved.

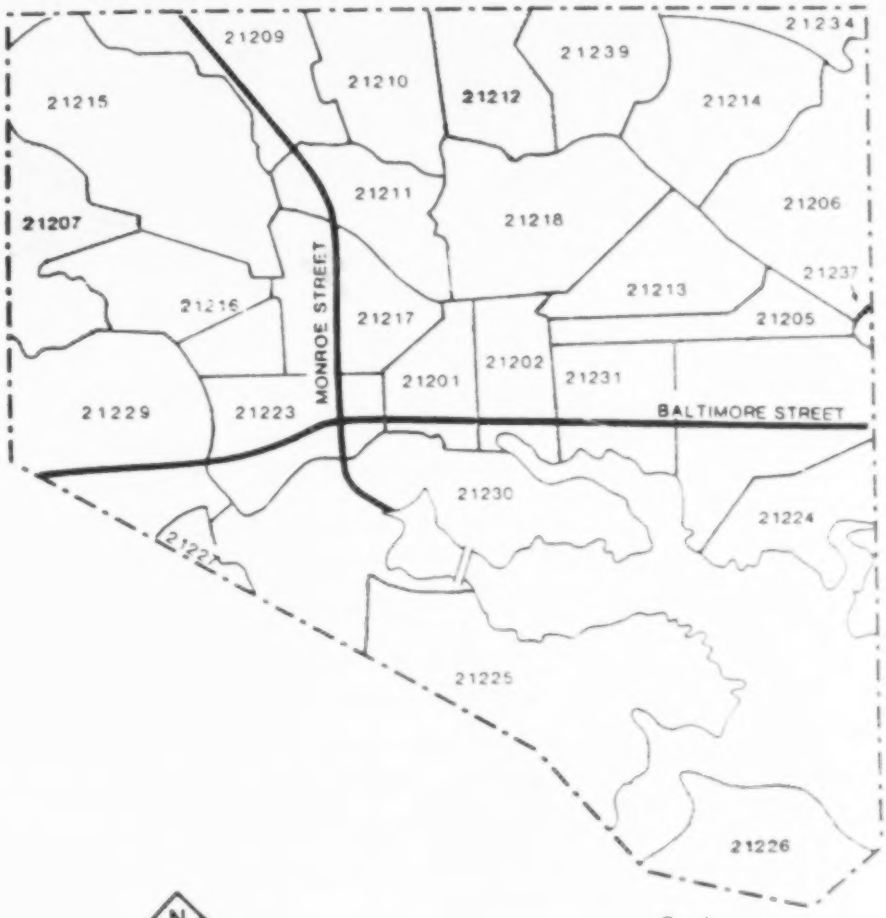
Each of the Baltimore areas identified only by the sentinel event method has high rates of two events. In 21207 the events are rheumatic fever and tuberculosis. In 21212 the events are rheumatic fever and measles. In 21226 the events are infant dehydration and tuberculosis. In 21237 the events are infant dehydration and rheumatic fever. The number of cases of rheumatic fever and infant dehydration is very small. These events are rare and a single case would be cause for concern about access to appropriate primary care. On the other hand, high rates of these relatively rare sentinel events alone may not indicate that an area is underserved.

The four Baltimore areas identified only by the sentinel event method all are adjacent to middle- and high-income suburbs. The underserved areas in these zip codes appear to be masked by the high-income areas, therefore making it difficult for these areas to be identified as a HMSA or MUA. Rare events, where only a few can trigger identification by the sentinel event method, are less likely to be masked than more common events. The population-to-physician ratio may be high for the overall zip code, reflecting the physicians in the adjacent suburbs and not those in the city. Similarly, the poverty rate, which largely drives the IMU score, is low for zip codes 21207, 21212, and 21237.

In Boston the areas identified only by the sentinel event method have high rates on at least three events, but the events do not appear to be related. For example, South Boston has high rates of infant dehydration, low birth weight, and tuberculosis; Hyde Park has high rates of uncontrolled hypertension and tuberculosis; Roslindale has high rates of infant dehydration and invasive cervical cancer; Harvard Square has high rates of measles, mumps, polio, and tetanus, and tuberculosis; and Union Square has high rates of measles, mumps, polio, and tetanus, rheumatic fever, and tuberculosis.

EXHIBIT 3.5

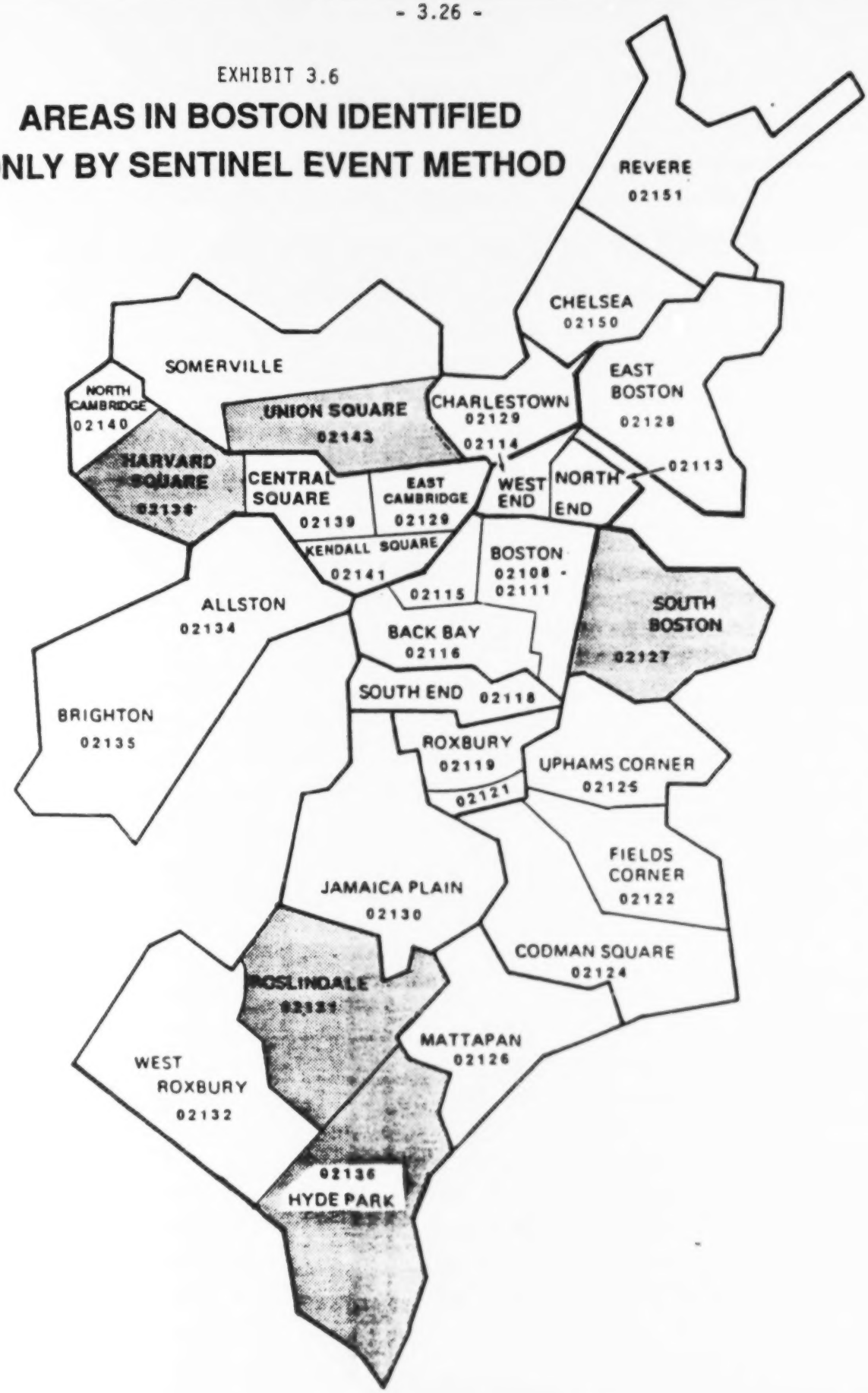
AREAS IN BALTIMORE IDENTIFIED ONLY BY SENTINEL EVENT METHOD



Lewin and Associates incorporated

EXHIBIT 3.6

AREAS IN BOSTON IDENTIFIED ONLY BY SENTINEL EVENT METHOD



Harvard Square, Hyde Park, Roslindale, South Boston, and Union Square all have subpopulations that appear to be underserved and lack resources to meet the health care needs of the community. Evidence for why each area appears to be underserved is provided below:

- **Harvard Square** has a predominantly student population, but it borders a few housing projects for low-income populations. The housing projects contain many high-risk individuals.
- **Hyde Park** is a predominantly blue collar, ethnic community. The area does not have a community health center and according to local program managers has tried to obtain designation as a HMSA, but lacked the local leadership to succeed in the process.
- **Roslindale** is composed largely of blue collar workers, many of whom are uninsured or underinsured. The area has one small neighborhood health center, but there is no public transportation available. Recently the area has seen a growing presence of low-income minority populations.
- **South Boston** has observed an increase in morbidity in recent years, and access to health care appears to be more difficult to obtain. The neighborhood health center almost closed in 1985. In addition, many of the manufacturing jobs have been replaced by service jobs, thereby increasing the rate of uninsurance in the area.
- **Union Square** is a lower working class population. There are high concentrations of new immigrants with some health status problems. The area has many physicians but they are reluctant to serve the low-income populations.

The sentinel event method also identified a number of areas outside the cities of Baltimore and Boston where data on other measures of underservice were unavailable. Therefore, these areas could not be compared to other measures of underservice. Follow-up is needed to determine whether or not these areas are underserved.

The sentinel event method as currently developed generally meets all three criteria laid out at the start of this process. It does not identify areas at random, it matches areas identified by other

measures of underservice, and it identifies areas which, while not identified by other measures, appear to be underserved when examined in other ways. While further work can refine the method, it appears to be an effective method to identify underserved areas. The method's most appropriate use at this point is as a trigger mechanism to identify areas that seem to have health status problems. Once these areas have been identified, program managers should examine them more closely to determine what barriers to primary care exist and the nature of those barriers.

The method may be particularly attractive to program managers because it requires judgment about the degree and nature of underservice in an area and does not mechanically determine whether or not underservice exists. Unlike the MUA method, which uses a score to determine underservice, the sentinel event method requires an evaluation of underservice once the initial areas have been identified. This allows the program manager to identify the nature of the problem and develop tailored solutions to address the particular problem.

B. TARGETING RESOURCES TO SPECIFIC POPULATION GROUPS

A second goal of the sentinel event method is to enable program managers and policy makers to identify particular population subgroups at risk, so that program managers and community health center directors can use the sentinel event method to target health services to specific age, race, or sex cohorts.

Based upon the analysis in Baltimore and Boston, it would appear that the sentinel event method has potential for use as a planning tool to target specific populations, although not to identify what services should be provided. The sentinel event method has potential for identifying at-risk populations along three dimensions: 1) age, 2) race, and 3) sex.

1. Age

Sentinel events may be useful in identifying particular age groups that face barriers to primary care, since in some areas the high events are clustered in certain age groups. For example, five areas in Baltimore (zip codes 21207, 21212, 21214, 21225, and 21237) and two areas in Boston (Roslindale and Uphams Corner) had high rates on only sentinel events affecting children. Areas with high rates of childhood events, but not adult events, may indicate that children face special barriers to access to care. Further investigation into these areas may reveal that children are receiving episodic care and do not have access to primary care. Another reason for the high rate of childhood events may be that providers in the area are not appropriate for treating childhood conditions. In addition, low-income working parents may not be getting their children into the doctor in a timely fashion because of a lack of extended evening and weekend hours.

Several areas had high rates of certain events among the elderly, but not other adults. The elderly were found to have particularly high rates of advanced cervical cancer, uncontrolled diabetes, uncontrolled hypertension, and tuberculosis in zip codes 21216, 21217, and 21224 in Baltimore and Mattapan and Roxbury in Boston. Although we cannot explain the problem in these areas, high rates of sentinel events among the elderly and average rates for other populations may indicate that the health services have placed outreach efforts on other populations. For example, the community health center in one area in Baltimore began as an effort directed toward women and children. Those groups have average rates of sentinel events while the elderly have significantly higher rates. In zip codes 21217 and 21223 in Baltimore, we found a much higher rate of invasive cervical cancer among the elderly. Because routine Pap tests are not covered under Medicare, elderly women may face financial barriers to early detection of cervical cancer.

The scope of the study did not permit examining other data sets to determine whether the areas actually had health status problems for those age groups. Therefore, at this point we can only conclude that the method has potential for being used to identify at-risk subpopulations. Further investigation is required to determine whether these groups are underserved.

One concern raised about using the sentinel event method to target specific age groups is that variation in the events might drive the conclusions. For example, the sentinel events chosen for children are more precise measures of access than those chosen for adults. As such, we may find more areas where children are at risk than adults based on the measure alone. We adjusted for the greater precision in children's conditions by setting the relative risk threshold higher for most of the adult conditions, but further work is needed to determine whether sentinel events can be used to mark age groups.

If further validation confirms that the method is useful to plan services, it could be used to target certain age groups. If, for example, a community health center finds high rates of sentinel health events affecting children and average rates for adult populations, it might design programs to get more children into the center. Similarly, an area that has directed resources toward women and children may find that those population groups do not have high rates of sentinel events, suggesting the success of those initiatives or other factors in reducing need, but that the elderly population does have high rates of sentinel events. Providers there might begin outreach efforts to bring the elderly into primary care.

2. Race

The sentinel event method identified areas where particular races seem to be at-risk for certain events. In zip codes 21201, 21216, 21217, and 22223 in Baltimore the Black population had significantly

higher rates of sentinel events than the white population. This largely confirms studies which have shown that Blacks have lower health status than whites. However, in one largely Black area in Baltimore (zip code 21223), we found white women to have high rates of invasive cervical cancer compared to all women and Black women. While we do not know the reason for this, one explanation may be that the health services available to low-income populations in this area are perceived to serve the Black population. Low-income white women may not be receiving routine primary care.

3. Sex

The sentinel event method also has potential for identifying areas with problems specific to men or women. A finding of high rates of advanced breast cancer, invasive cervical cancer, and low birth weight infants might indicate that women face barriers to care while high rates of tuberculosis and uncontrolled diabetes and hypertension among men might indicate this group is at-risk.

In zip codes 21217, 21223, and 21231 in Baltimore high rates of invasive cervical cancer and low birth weight infants were observed among women. Because these two events require follow-up care by a primary care provider, women in these areas may be receiving episodic care and may lack access to ongoing primary and preventive health care. If a women has an abnormal Pap test, follow-up must be done to prevent invasive cervical cancer. Similarly, adequate prenatal care requires access to a regular source of primary care.

We found two areas in Baltimore (zip codes 21201, 21216) with high rates of tuberculosis and uncontrolled hypertension among men. One explanation for this may be that low-income men comprise a higher proportion of the uninsured than low-income women, since more women are eligible for Medicaid. A finding of high rates of sentinel events among men, but not women and children, may indicate that the services for

women and children are meeting their goals, but that additional services are required to meet the needs of men in the area.

While the sentinel event method can identify certain age, race, and sex groups with high rates of sentinel events, the method should not specify what services should be provided. For example, an area with a high rate of advanced breast cancer and low birth weight may indicate that women in the area have health status problems. However, women in those areas are probably at risk for other health conditions as well as breast cancer and low birth weight infants. The method does not warrant narrowing the focus of services to address only those specific sentinel events. While a program of breast cancer screening and prenatal care may be desirable, the focus of the effort should be women's total health and not only those two events. Subsequent analysis of data bases with many more events might allow refinement of service needs, but limited analysis of a few sentinel events does not.

This chapter has shown that the sentinel event method has great promise in identifying possible areas of underservice in urban areas and may assist policy makers and program managers in targeting services toward specific population groups. However, the practicality of the method is as important as the effectiveness of the method if it is to be used. How practical and easy the method is to administer is described in the next chapter.

CHAPTER FOUR
PRACTICALITY OF THE SENTINEL EVENT METHOD

To be useful, the sentinel event method must be practical and relatively easy to understand and administer. In determining its practicality, we tested the method in parts of Maryland, Massachusetts, and North Carolina and then assessed how generalizable that experience is likely to be to other areas of the country.

The method proved to be practical and easy to administer. At the start of the project, there was concern that the complexity of developing the method might limit the practicality of the method. However, we found that the method, once developed, can be practically applied to small areas. Since the method is not expensive and components of the method are easy to understand, it can be implemented by program managers and policy makers. However, the key factor influencing the practicality of the method for a particular area is the availability of quality data to measure the incidence of sentinel health events.

This chapter highlights how the method can be practically applied in other localities. It describes the components needed to use the method and then outlines a model process for applying it.

A. COMPONENTS NEEDED TO USE THE METHOD

Two major components are needed to use the sentinel event method: 1) quality data to measure the number of cases of sentinel events and the population at risk, and 2) resources to analyze and interpret the data. Both these components are currently available in many state and local areas.

1. Quality and Availability of Data

The quality and availability of data that can be used to measure the incidence of sentinel health events have increased dramatically in the last decade. The ability of state and local officials to collect and analyze these data has also increased; this is likely to continue in the future. However, even with the wealth of data available at the state and local level, the practicality of using sentinel health events is likely to vary by state based on current data collection practices.

Applying the method requires the cooperation of those agencies who have the data, most commonly the state and local health departments, local health systems agencies, primary care associations, and independent data agencies. Convening a meeting of the state and local organizations responsible for collecting the necessary data can inform interested individuals about the study, learn about the data sources in the state, and generate enthusiasm for the study. We held a meeting of this type in Baltimore and Boston which proved extremely beneficial.

a. Data Sources to Measure the Number of Cases of Events

Four data sources are needed to measure the number of cases of each event:

- Hospital discharge data.
- Data on reportable diseases.
- Birth certificate data.
- Tumor registry data.

Hospital discharge data. A computerized centralized or regionalized hospital discharge data base is essential for analyzing the hospital-based sentinel health events (dehydration, asthma, rheumatic

fever, invasive cervical cancer, uncontrolled diabetes, and uncontrolled hypertension). In a centralized system hospital discharge summaries have been standardized to permit an analysis of all hospitals in an area. Hospital discharge data provide diagnosis and procedure codes and the patient's age, race, and sex. Some hospital discharge summaries also report patient zip code and expected payer source, which permits matching of diagnosis and procedure with the demographics of a zip code and with patient insurance status.

Data are requested from the hospital discharge abstracts by providing a list of diagnosis (ICD-9) codes and procedure codes that comprise the sentinel health events. These codes are grouped to define sentinel events. The list of ICD-9 codes for each event is found in Appendix B.

Currently five states (Arizona, California, Massachusetts, Missouri, and New York) have operational centralized hospital discharge data bases. Eight other states (Connecticut, Illinois, Maine, North Carolina, Pennsylvania, Vermont, Washington, and West Virginia) have enacted legislation to create them. Within the next five years, analyzing sentinel events using hospital discharge data will be practical in the majority of the states. In the meantime, sentinel event analysis is possible in states without a centralized data base, but it is more difficult. Data may be obtained from a regionalized abstracting service or a hospital association that collects these data. This may be feasible for small area analysis where only a few hospitals will be analyzed. It is more problematic to apply the method to the entire state without a centralized data base.

Records of reportable diseases. State and local health departments are required to report data on communicable diseases such as measles, mumps, polio, tetanus, and tuberculosis to the Centers for Disease Control. Therefore, state and local health departments usually maintain data on the number of cases of these diseases. Variation

exists in whether the data are available by county, town, zip code, or census tract and whether demographic data are available. For example, we found these data were available by census tract in Baltimore, by zip code in Boston, by town in Berkshire and Franklin counties, and by county in Halifax and Hertford counties.

Data are obtained from the health departments by providing them with table layouts specifying the information required. A sample table layout is found in Appendix C. In our field testing, the timeframe for receipt of the data ranged from two to six weeks, depending on whether the data were on computer or had to be abstracted from hard copy.

Birth certificate data. Birth certificates are a source of data for low birth weight infants and the receipt of prenatal care among women. These data are generally available from the State Bureau of Vital Statistics (usually within the Health Department), which is responsible for collecting the birth certificate data that will eventually be sent to the National Center for Health Statistics.

In general birth certificate data include outcome information, trimester of prenatal care, number of prenatal care visits, and demographic information. In some states, information on month of prenatal care is incomplete or inaccurate. Information on socioeconomic status is not linked with birth certificates. However, the town, zip code, or census tract of the mother is included, which may be matched with the area's socioeconomic status from Census data.

Data are obtained by submitting table layouts specifying the variables needed. It is preferable to obtain the birth certificate data on computer tape if the state can make it available in that form. This eliminates the need for data entry from hard copy.

Tumor registry. Data on advanced stages of cancer are available from tumor registries in many states. These states maintain

registries to monitor cancer cases and report to the National Cancer Institute. If a state does not keep tumor registry but has a hospital discharge data base, information may be obtained for hospitalized patients with cancer.

When both tumor registry data and hospital discharge data were used to measure advanced cervical cancer, as in Massachusetts, the conclusions were the same. Although the hospital discharge data identified more cases of cancer than the tumor registry (probably because of multiple admissions for some patients), most of the same areas were identified as being at-risk by both data sources.

However, a tumor registry is the preferable source for cancer information because it contains information on the staging of the disease, and represents a more accurate measure of the incidence of cancer because it counts tumors instead of admissions. Hospital discharge data can be used to derive advanced stages of cancer by combining ICD-9 codes with procedure codes. For example, a diagnosis of cervical cancer may be combined with the procedure code for a hysterectomy to obtain cases of invasive cervical cancer. One advantage of using the hospital discharge summaries is that payer source may be obtained, a variable usually not collected by tumor registries.

b. Data Sources to Measure the Population At-risk

Two data sources are required to measure the population at risk:

- Census Bureau data.
- Birth certificate data.

Census Bureau data. Census data are available by zip code and census tract and can be used to measure the population denominators for computing the incidence rate of sentinel events. These data provide

demographic information, such as age, sex, race, and income, on an area to permit the calculations of age, race, and sex-specific incidence rates. One problem with the Census data is that they are now eight years old; if demographic patterns have changed in an area, the old data will distort the results of the sentinel event analysis. If a state has conducted a mid-decade census, these data might provide a more accurate representation of the incidence of the area's demographics.

Birth certificate data. Data on the total number of births in a zip code or census tract are available from birth certificate data. These data provide the best measure of the population at-risk for low birth weight infants. They include demographic information, such as age and race of the mother, which can be used to analyze the incidence of low birth weight among particular at-risk groups, such as Blacks and teenage mothers.

2. Resources Required to Use the Method

The resources required for state and local organizations to use the sentinel event method are not extensive. In fact they are already in place in many health care organizations. The method does not require a statistician or epidemiologist to conduct the analysis; it can be used by existing staff. Two types of resources are needed: 1) computer capability, and 2) personnel to conduct the analysis.

a. Computer Resources

Most of the sentinel event analysis can be conducted on a personal computer, although access to a mainframe computer is needed for analyzing large data tapes or for downloading data onto a personal computer. The software needed to compute incidence rates and produce cross tabulations include spreadsheet programs, such as LOTUS 123 or SUPERCALC, a database manager, such as DBASE, or statistical programs, such as SAS or SPSS.

The type of analysis required involves sorting large data bases and producing cross tabulations of different variables. It does not require sophisticated computer programming or statistical analysis.

b. Personnel Resources

Three types of personnel are needed to conduct the analysis: 1) a data entry person, 2) a computer programmer, and 3) a senior program specialist. Their roles and our estimates of their required levels of effort are:

- The data entry person enters hard copy data onto computer spreadsheets. The amount of time required for this person depends on whether the user was able to obtain the majority of the data on computer tape. Assuming hard copy data on reportable diseases and tumor registry data are obtained, the required level of effort is three weeks.
- The computer programmer analyzes the data obtained on computer tape and computes incidence rates and relative risk. The required level of effort is one month.
- The senior program specialist supervises the analysis and conducts interviews with local experts to verify the conclusions. The required level of effort is three weeks.

Most state and local organizations will already have these types of personnel on staff or can access them on a part-time basis.

B. A MODEL PROCESS FOR USING THE METHOD

Having described the data and resources required to use the sentinel event method, this section describes how they can be integrated into a model process. The process may vary somewhat by area depending on who is using the method and for what purpose and the availability of data. Potential users of the method may be state and local health departments, a hospital system, primary care associations, or a large primary care center. The model process for using the method has four steps:

- Convening a work group to discuss how the sentinel event method will be used.
- Determining data requirements and preparing data requests.
- Conducting data analyses.
- Reviewing findings with work group members.

Each step is described below.

1. **Convene Work Group**

The first step under this model is to convene a work group. The work group serves three purposes. First, it provides a forum for discussing how the method will be used. This includes reviewing where the method will be used, how many events will be examined, and for which population groups. For example, a state health department may plan to use the method to determine where the underserved areas are in the state, while a community health center with several sites may use the method to plan service efforts directed toward specific populations. In each case, the application of the method would differ.

Second, the work group provides information about the availability of data for conducting the analysis. The final list of events to be analyzed depends on whether quality data sources are available to measure the events. For example, advanced breast cancer would not be chosen as an event if the state does not have a tumor registry. In addition to discussing the availability of data, the work group provides valuable information about the limitations of the data. For example, in Massachusetts we learned that information on race from the hospital discharge data base was incomplete and could not be used in the analysis.

The last purpose for convening a work group is to generate enthusiasm for the study and establish contacts for future follow-up.

By holding these work groups in Baltimore and Boston we were able to efficiently identify data sources and have higher priority placed on the requests than otherwise might have been the case. Further, since using the method is a two-step process of identifying areas and determining if those areas are underserved, the work group can provide the necessary "reality testing" of conclusions. Once "high sentinel event" areas have been identified, the work group can help determine if these areas are indeed underserved and what appears to be causing the problem.

The work group may be composed of state and local policy makers, data analysts, local primary care providers, and others knowledgeable about access to primary health care. Two areas of substantive knowledge are required: 1) knowledge of data sources that are available to analyze sentinel events and the limitations of those data sources, and 2) experience examining barriers to access to primary care in local areas.

2. Determine Data Requirements and Prepare Requests

Before collecting the data, users of the method should determine the specific data required to conduct the analysis. This includes deciding which sentinel events will be used, whether the data will be collected by demographic variables, such as age, race, and sex, and whether the data are to be provided on computer tape or hard copy.

Data requirements can be grouped into three categories: 1) the number of cases of each sentinel event in an area, 2) the population used to derive the incidence rate of each event, 3) measures of underservice to be compared to the sentinel event results:

- Data are needed on the number of cases of each event in an area. Users must decide if they intend to analyze events by age, payer, race, and sex. This will largely depend on the availability of data for these factors.

- Population denominators are required to calculate an incidence rate for each event. They should reflect the population at risk for the event as closely as possible. For example, the number of births, and not total infants, is the appropriate denominator for computing the incidence of low birth weight infants. The denominators must also correspond to the numerator in terms of demographic characteristics. For example, if we are interested in examining the rate of invasive cervical cancer among Black women, the denominator would be the number of Black women in the area. Careful attention should be paid to the selection of denominators, as they are likely to vary by area depending on the sophistication of available data. For example, some data sets will have only a white/nonwhite split and not identify Blacks separately.

- Measures of underservice include the list of HMSA areas, MUA areas with the IMU score, the population-to-physician ratio, percent of the population below 150 percent of poverty, and the insurance status of the population. These measures serve to validate the findings from the sentinel event method. Comparisons to other measures are made to determine how much overlap there is with the sentinel event method, to help explain why an area has a high rate of sentinel events, and to identify underserved areas that appear to be missed by the other measures.

Section A described the data sources for the number of cases of the events and the population denominators. Measures of underservice are available from the Federal Register list of HMSA and MUA areas, from a state or local health department, or a primary care association.

Once the data requirements have been identified, the data requests should be prepared. In requesting the data, the format should be specified. In general it is easier to work with data received on computer tape; however, this is not always possible. If a data tape is requested, the request should include exact specifications of the items to be included on the tape. If hard copy is requested, clear table layouts should be provided. Users should allow at least one month between submitting the data requests and receipt of the data. This period may be longer in states where the data are not automated.

best copy available

3. Conduct Data Analysis

The analysis of sentinel health events is straightforward and does not entail sophisticated computations. Once the data have been received, incidence rates are computed for each event for the total population and for any subpopulations of interest. Incidence rates are computed for each area of interest (e.g., county, zip code, groups of zip codes) and for the overall area (e.g., state, city). For example, the incidence rate per 1,000 population of infant dehydration in South Boston was calculated as follows:

$$\frac{\text{52 (Number of Cases in South Boston)}}{\text{317 (Number of Infants in South Boston)}} = 1{,}000 = 163.4$$

(South Boston's Incidence Rate for Infant Dehydration)

A relative risk is then computed by taking the ratio of the subarea incidence rate to the overall area incidence rate. For example:

$$\frac{\text{163.4 (Incidence of Dehydration in South Boston)}}{\text{75.3 (Incidence of Dehydration in Boston)}} = 2.17$$

(South Boston's Incidence Rate for Infant Dehydration)

A relative risk ratio of 1.0 represents no difference between the two areas that are being compared. Ratios greater than 1.0 indicate that more of a sentinel event is being seen in the numerator area, in this case South Boston. How much greater the ratio must be than 1.0 to signal a health status problem is a matter of judgment. The threshold ratios shown in Table 2.1 represent the judgment of the sentinel events Advisory Committee. These should be used as guidelines for determining high rates of events, not as absolutes. Users might consider raising and lowering the thresholds to determine how much the conclusions vary if specific threshold levels are changed. (A discussion of incidence rates, relative risk, and thresholds is provided in more detail in Chapter Two.)

The areas identified as underserved by the sentinel event method should then be compared to existing measures of underservice (e.g., HMSA, MUA) to determine how the sentinel event method tracks with other measures of underservice and whether further investigation is needed into areas that are either identified as 1) HMSA and/or MUA but not sentinel events, or 2) by the sentinel event method, but not by HMSA and/or MUA.

4. **Review Findings with Work Group Members**

We recommend that the findings be reviewed with members of the work group and others to assure that they seem reasonable to those knowledgeable about access to care in the area and to clarify any apparently contradictory findings. Of particular interest are those areas which do not correspond to other measures of underservice.

Interviewing local experts can provide reasons for why the sentinel event method did not identify areas which are designated as HMSA or MUA. For example, in Boston, one such area has been successful in obtaining the necessary resources to serve the needs of the underserved population. On the other hand, these interviews can inform us about whether areas identified only by the sentinel event method are underserved or whether the areas was identified at random. If they are underserved, these interviews can explain what barriers to access exist and why the area has not been designed by other methods of underservice. We found local policy makers and program managers in Baltimore and Boston to be very cooperative in providing insight into why certain areas had high rates of sentinel events and why other areas did not have high rates of sentinel events.

CHAPTER FIVE
NEXT STEPS

The sentinel health event method has promise for identifying areas and population groups who face barriers to good primary care. In this chapter we will explore the potential for incorporating the method into other measures of medical underservice, outline the steps needed to further refine, validate, and implement the method, and discuss changes sought in the basic data sets to strengthen the analysis.

A. INCORPORATING SENTINEL HEALTH EVENTS INTO OTHER MEASURES OF MEDICAL UNDERSERVICE

The sentinel event method provides information about the relative health status of areas and populations that the existing measures of Medically Underserved Area (MUA), Health Manpower Shortage Area (HMSA), and Need/Demand Assessment do not capture:

- MUA uses only infant mortality as a health indicator.
- HMSA formally incorporates health status in its method only for determining designations for areas with population-to-physician ratios between 3,000:1 and 3,500:1. The major health status indicator is infant mortality.
- Need/Demand Assessment balances the expected primary care visit demand against an area's capacity for supplying those visits. While grant applicants may give evidence about health status indicators in their service areas, there are no objective criteria or processes suggested for doing so.

The sentinel event method appears to identify areas or populations that may be missed by the other methods; it also provides more information about those areas spotted by MUA or HMSA. For example, it offers the potential to highlight the needs of certain population groups or age/sex cohorts. In contrast, both MUA and HMSA treat the population of a geographic area as a whole.

At its present stage of development, the sentinel event method can best be used as a supplement to existing methods but not as a replacement for them. More work is needed on validating the method and putting the necessary data systems in place throughout the country, as is discussed below. However, even in the short-term the method can:

- Guide the inclusion of health status indicators into HMSA and the Need/Demand Assessment. The sentinel event method cannot be incorporated directly into the MUA process, but it could provide a means for taking a closer look at areas identified in MUA.
- Aid those states and local areas that already have good data sets to plan their use of health care resources. For example, Massachusetts could use the method to help qualify areas for the proposed state physician service-contingent loan forgiveness program.
- Assist primary care networks, state agencies operating under Cooperative Agreements, and primary care associations to do more sophisticated and realistic planning for care. For example, the method may highlight areas where children's care is a particular problem.

The method is designed to surface areas and populations whose health status indicators are signaling a problem with access to good primary care. It does not of itself specify whether the problem springs from lack of physicians, financial barriers to care, poor patient care-seeking behavior, or other causes. This reflects some limitations to the method, but we believe it also to be a strength since the appropriate intervention strategy will then result from the professional judgment of health program managers and not be designed strictly by the numbers.

In the longer run the sentinel events method has the potential for playing a larger role in flagging areas and populations with needs:

- As more states implement centralized data sets and develop more sophisticated information systems, the method could be applied to larger areas and, perhaps, the whole United States.

- If the method is further validated, it could substitute for existing methods, particularly when data are lacking for the HMSA and MUA processes. For example, both HMSA and MUA require measures of full-time-equivalent physicians, which are difficult to acquire in many areas and often mean conducting telephone surveys of doctors' offices. The sentinel event method uses no primary data collection.

- In the future, the sentinel event method might be used to evaluate the outcomes of health programs. It may be possible to calculate the relative risk for the various events and then check it again one to three years later. This could be a powerful tool for measuring the actual impact of programs, not just their costs or utilization.

Although the sentinel event method has the potential for serving these long-range purposes, before they become a reality the method must be further refined and validated and current barriers to implementation removed.

B. NEXT STEPS IN REFINING, VALIDATING, AND IMPLEMENTING THE METHOD

Developing and field-testing the sentinel event method has been an arduous process, but the method's promise makes the efforts worthwhile. Among the next steps that HRSA can take are:

- Taking a closer look at the high sentinel event areas in Baltimore and Boston. The high event areas seem to make sense to observers familiar with health care needs and services in those cities, but in-depth case studies of selected areas would provide further evaluation of the method.

- Comparing the incidence rates for the sentinel events in the test sites with those for the nation as a whole. For those events that rely on hospital data, comparisons can be made with the National Hospital Discharge Survey and the MedPar (for Medicare patients).

- Conducting further tests in rural areas. Rather than selecting paired counties as was done in this project, additional tests should examine each of the rural counties in a state. This would require a centralized state data source, such as those available in Arizona, California, Massachusetts, Maryland, and New York.

- If the method is further validated, it could substitute for existing methods, particularly when data are lacking for the HMSA and MUA processes. For example, both HMSA and MUA require measures of full-time-equivalent physicians, which are difficult to acquire in many areas and often mean conducting telephone surveys of doctors' offices. The sentinel event method uses no primary data collection.

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- Developing a manual for a model sentinel event method and then assisting two to three states or local areas to try it for themselves. These could be states that have shown progress in planning under the State Cooperative Agreements and that are ready for the next step.

Implementing the sentinel event requires continued growth in the development of state and federal health data bases. HRSA should encourage their development beyond the more limited role of hospital cost reporting to incorporate data useful for public health planning, including the sentinel event method. Additional information that would facilitate implementing the sentinel event method are:

- Geocoded patient address into areas smaller than zip codes. In many locales zip codes are too large a geographic area and may contain distinct subpopulations. This would be accomplished by retaining the patient's address on hospital discharge and birth certificate data, and having the abstracting system recode to census tracts. Census tracts are smaller and more homogeneous, and therefore better units of analysis than zip codes.

- Information on patient income level, to know whether those with high rates of sentinel events are low income. This could be accomplished by requesting the patient's income level, in ranges, on the hospital discharge summary or birth certificate. This could be done at time of admission or upon completion of the information for birth certificates. Since this request may meet patient resistance, it should be tested in a few institutions before general application.

- Information on health insurance status to enable better understanding of population characteristics by insurance status. HRSA should encourage the addition of a question on insurance status in the Census.

The sentinel event method proved to be a promising new tool for identifying areas. Further work is required to refine and validate the method before incorporating it into measures of underservice.

APPENDIX A

MATRIX OF SENTINEL EVENTS BY ZIP CODE IN BALTIMORE AND BOSTON

APPENDIX A

SENTINEL HEALTH EVENTS BY ZIP CODE
BALTIMORE

ZIPCODE	IHD SCORE	POVERTY	POPULATION	DEHYDRATION N	DEHYDRATION RISK	RHEUMATIC N	RHEUMATIC RISK	HYPERTENSION N	HYPERTENSION RISK	DIABETES N	DIABETES RISK	CERVICAL N	CERVICAL RISK	TB N	TB RISK	MEASLES N	MEASLES RISK	LBW N	LBW RISK
21217	38.6	55	59242	3	1.81		0.00	1071	2.66	689	2.48	62	2.28	66	5.39	16	0.64	795	1.78
21223	38.6	62	42435	2	1.66	2	4.82	563	1.95	468	2.37	47	2.42	65	5.03	6	3.23	614	1.60
21216	45.6	36	47651	6	6.12		0.00	721	2.13	486	2.10	44	1.93	43	3.11	5	2.72	492	1.64
21201	45.8	62	16985	2	6.22		0.00	285	2.47	201	2.84	9	1.16	27	3.71	2	3.32	214	1.83
21218	46.9	33	61908	1	0.62		0.00	461	1.02	429	1.39	37	1.22	52	1.96				1.35
21211	48.9	25	20917	0	0.00		0.00	132	0.92	89	0.91	12	1.24	16	1.79	1	1.43	112	0.94
21230	50.9	35	37556	0	0.00	1	3.06	385	1.49	328	1.86	24	1.36	19	1.24		0.00	311	1.20
21202	56.8	66	25747	0	0.00		0.00	205	1.07	193	1.48	17	1.32	34	3.09	2	1.83	332	1.66
21213	56.9	39	51771	3	2.44		0.00	534	1.48	484	1.96	46	1.89	46	2.98	6	2.90	844	1.84
21215	57.7	34	82449	6	2.88		0.00	1085	1.93	625	1.62	48	1.27	47	1.33	7	2.05	809	1.64
21205	58.3	43	24941	0	0.00		0.00	209	1.23	216	1.86	32	2.80	23	2.16	5	4.85	270	1.32
21231	60.1	50	18048	0	0.00		0.00	168	1.36	148	1.75	37	4.46	13	1.66		0.00	214	1.61
21224	60.1	26	56522	0	0.00		0.00	433	1.08	286	1.04	64	2.37	55	2.27	8	4.37	287	0.92
21005		39	6276	0	0.00			2	0.04	3	0.08		0.00				0.00	28	0.78
21225		33	37783	0	0.00	1	2.87	447	1.66	211	1.15	21	1.16	1	0.06	4	2.56	328	1.31
21226		32	8771	1	8.73		0.00	58	1.21	26	0.78	6	1.83	7	2.42		0.00	54	0.99
21163		27	1675	0	0.00		0.00	6	0.47		0.00		0.00				0.00	8	1.06
21132		25	1227	0	0.00		0.00	8	0.95	3	0.62		0.00				0.00	5	0.66
21001		23	16520	1	2.06			232	1.88	104	1.23	8	1.08				0.00	119	1.02
21160		22	1628	0	0.00		0.00	11	0.98	2	0.26		0.00				0.00	5	0.54
21229		21	56732	1	0.77		0.00	501	1.24	340	1.23	42	1.54	16	0.62	1	0.48	457	1.25
21078		21	13737	0	0.00	1	8.24	269	2.76	112	1.68	14	2.13				0.00	77	0.98
21040		20	18192	0	0.00	1	4.40	90	0.71	79	0.92	20	2.36				0.00	136	0.84
21154		20	5769	0	0.00	1	17.24	30	0.73	17	0.61	1	0.36				0.00	18	0.66
21144		19	20109	0	0.00		0.00	64	0.46	59	0.62	9	0.95				0.00	112	0.81
21034		19	2488	0	0.00		0.00	35	2.02	16	1.35	6	4.27				0.00	17	0.74
21053		18	2098	0	0.00		0.00	4	0.26	1	0.09		0.00				0.00	4	0.41
21220		18	36194	2	1.67		0.00	141	0.53	179	0.98	26	1.44				0.00	194	0.83
21107		17	1678	0	0.00		0.00	3	0.25	4	0.49	1	1.24				0.00	8	0.91
21221		17	42830	0	0.00	1	2.94	202	0.62	222	1.00	9	0.41				0.00	250	0.93
21237		16	24684	2	4.50	1	6.28	121	0.64	81	0.63	9	0.71				0.00	133	0.81
21212		15	37599	0	0.00	2	6.83	227	0.88	210	1.18	2	0.11	11	0.68	3	2.28	199	1.00
21206		15	55407	3	2.06		0.00	270	0.66	242	0.87	20	0.73				0.00	319	0.98
21076		14	4001	0	0.00		0.00	14	0.45	18	0.85	6	2.89				0.00	30	0.92
21117		14	18771	0	0.00		0.00	78	0.55	92	0.94	1	0.10				0.00	82	0.65
21157		13	33323	3	8.71		0.00	173	0.73	58	0.34	10	0.62				0.00	124	0.64
21113		13	7777	0	0.00		0.00	13	0.23	20	0.51		0.00				0.00	26	0.60
21102		13	4467	0	0.00		0.00	13	0.42	7	0.33		0.00				0.00	20	0.76
21227		13	40628	0	0.00		0.00	231	0.77	115	0.66	21	1.04				0.00	192	0.75
21207		13	73149	2	1.10	1	1.70	581	1.05	359	0.95	9	0.24	25	1.86	3	1.14	488	1.10
21239		13	29613	0	0.00		0.00	223	1.03	130	0.88	12	0.62	3	0.24		0.00	165	1.01
21048		12	7145	0	0.00		0.00	23	0.44	12	0.34	1	0.28				0.00	41	0.94
21214		12	22748	1	2.17		0.00	125	0.79	68	0.63	10	0.94	6	0.62	1	1.41	96	0.71
21061		12	73026	0	0.00	1	1.62	370	0.66	339	0.88	37	0.98				0.00	337	0.73
21111		11	3515	0	0.00		0.00	8	0.33	11	0.66		0.00				0.00	9	0.56
21209		11	19632	2	5.26		0.00	115	0.80	33	0.33		0.00				0.00	71	0.71
21152		11	2235	0	0.00		0.00	9	0.54	3	0.26		0.00				0.00	10	0.78
21161		11	3219	0	0.00		0.00	14	0.63	7	0.46	1	0.87				0.00	12	0.60
21136		10	22966	0	0.00		0.00	80	0.47	79	0.88	4	0.35				0.00	117	0.83
21219		10	8065	0	0.00		0.00	62	1.04	42	1.03	1	0.26				0.00	28	0.62

SENTINEL HEALTH EVENTS BY ZIP CODE
BALTIMORE

ZIPCODE	IMU SCORE	POVERTY	POPULATION	DEHYDRATION N	DEHYDRATION RISK	RHEUMATIC N	RHEUMATIC RISK	HYPERSTENSION N	HYPERSTENSION RISK	DIABETES N	DIABETES RISK	CERVICAL N	CERVICAL RISK	TB N	TB RISK	MEASLES N	MEASLES RISK	LBW N	LBW RISK
21037	10		12414	0	0.00		0.00	41	0.45	27	0.44		0.00				0.00	55	0.44
21120	10		4017	0	0.00		0.00	7	0.23	9	0.43	1	0.49				0.00	8	0.45
21122	10		39080	0	0.00		0.00	197	0.68	168	0.85	5	0.28				0.00	134	0.57
21074	9		8244	0	0.00		0.00	38	0.83	28	0.68	4	0.89				0.00	27	0.66
21228	9		40352	0	0.00		0.00	229	0.79	80	0.40	18	0.92				0.00	117	0.65
21210	9		12208	0	0.00		0.00	49	0.66	4	0.07	3	0.51	2	0.38		0.00	22	0.67
21071	9		1502	0			0.00	9	0.88	3	0.43	3	4.33				0.00	10	1.33
21032	9		8109	0	0.00		0.00	26	0.58	34	1.10	6	1.97				0.00	19	0.56
21234	9		65749	1	0.72		0.00	305	0.61	153	0.45	22	0.66				0.00	248	0.71
21162	8		2787	0	0.00		0.00	18	0.85	13	0.89		0.00				0.00	5	0.45
21085	8		16520	0	0.00		0.00	95	0.81	72	0.90	3	0.36				0.00	82	0.75
21155	8		1478	0	0.00		0.00	9	0.77	4	0.50		0.00				0.00	12	1.03
21030	8		18235	0	0.00		0.00	76	0.53	26	0.25	2	0.21				0.00	60	0.66
21014	8		27378	0	0.00	3	220.18	168	2.66	70	1.63	10	2.37				0.00	91	0.64
21050	8		8000	0	0.00		0.00	43	0.76	28	0.72	1	0.28				0.00	21	0.64
21057	8		3704	0	0.00		0.00	11	0.40	1	0.05		0.00				0.00	4	0.30
21028	8		2500	0	0.00		0.00	22	1.22	5	0.41	2	1.65				0.00	7	0.64
21087	7		4143	0	0.00		0.00	18	0.58	10	0.47	1	0.48				0.00	5	0.33
21108	7		9540	0	0.00		0.00	38	0.52	23	0.48	3	0.81				0.00	35	0.61
21131	7		4862	0	0.00		0.00	12	0.32	11	0.43		0.00				0.00	19	0.88
21044	7		21413	0	0.00		0.00	80	0.38	47	0.44		0.00				0.00	71	0.64
21204	7		38807	1	3.08		0.00	236	0.82	72	0.36	2	0.10				0.00	69	0.64
21208	7		26429	0	0.00		0.00	174	0.88	66	0.48	5	0.38				0.00	77	0.74
21236	7		23255	0	0		0	67	0.38	49	0.4	5	0.42				0.00	90	0.51
21104	7		2078	0	0.00		0.00	7	0.46	12	1.16	1	0.98				0.00	7	0.69
21084	6		5451	0	0.00		0.00	34	0.88	11	0.42		0.00				0.00	19	0.68
21009	6		4277	0	0.00			32	0.94	22	0.94		0.00				0.00	28	0.69
21054	6		8288	0	0.00		0.00	20	0.35	11	0.28		0.00				0.00	18	0.51
21043	6		28481	0	0.00		0.00	75	0.34	98	0.65	10	0.67				0.00	95	0.66
21133	6		23093	1	8.32		0.00	136	0.80	95	0.81	5	0.43				0.00	80	0.71
21045	6		27724	0	0.00		0.00	76	0.39	64	0.48	7	0.53				0.00	134	0.66
21047	6		10233	0	0.00		0.00	45	0.60	16	0.31	1	0.20				0.00	15	0.43
21140	5		1252	0	0.00		0.00	4	0.44	6	0.98		0.00				0.00	6	0.43
21013	5		3533	0	0.00			12	0.48	2	0.12		0.00				0.00	14	0.83
21146	5		20378	2	4.87		0.00	68	0.37	63	0.60	3	0.29				0.00	42	0.48
21128	5		2628	0	0.00		0.00	25	1.17	15	1.03	2	1.38				0.00	3	0.30
21090	5		10128	0	0.00		0.00	68	0.66	23	0.43	5	0.94				0.00	28	0.68
21029	5		2719	0	0.00		0.00	2	0.10		0.00		0.00				0.00	8	0.63
21035	5		4158	0	0.00		0.00	10	0.33	9	0.43	4	1.94				0.00	5	0.26
21046	5		3474	0	0.00		0.00	11	0.42	12	0.67	3	1.70				0.00	32	0.61
21114	5		12778	0	0.00		0.00	13	0.14	5	0.08	1	0.15				0.00	58	0.84
21012	4		13955	0	0.00			33	0.32	25	0.35	4	0.57				0.00	52	0.59
21093	4		26876	0	0.00		0.00	96	0.46	28	0.18	3	0.22				0.00	53	0.53
21052	0		1013	0	0.00		0.00	6	0.77	5	0.93		0.00				0.00	0	0.00
TOTAL			1920147	46	1.71	16	0.04	13817	10.64	9454	7.28	931	1.43	586		72	0.19	11907	

SENTINEL HEALTH EVENTS BY ZIP CODE
BOSTON

ZIPCODE	IMU SCORE	POVERTY	TOTPOP	RHEUMATIC N	RHEUMATIC RISK	INFANT DEHYDRATION N	INFANT DEHYDRATION RISK	CERVICAL CANCER HOSPITAL N	CERVICAL CANCER HOSPITAL RISK	CERVICAL CANCER TUMOR REGISTRY N	CERVICAL CANCER TUMOR REGISTRY RISK	BREAST CANCER TUMOR REGISTRY N	BREAST CANCER TUMOR REGISTRY RISK
02119	38.4	50	24,469		0.00	89	3.39	35	4.23	7	4.23	21	1.15
02121	38.4	47	24,393		0.00	60	1.74	19	2.34	3	1.84	10	0.56
02118	46.8	42	19,945		0.00	34	2.99	17	2.74	4	3.23	5	0.36
02116	46.8	26	19,942		0.00	7	0.69	5	0.66	1	0.66	9	0.54
02125	47.8	40	29,183		0.00	75	1.88	6	0.84	5	2.62	19	0.90
02126	49.6	29	26,783	2	9.91	51	1.90	20	2.28	3	1.71	15	0.77
02113	53.1	28	6,830		0.00	1	0.28	1	0.36		0.00	6	0.99
02124	53.2	36	49,335	1	2.87	140	2.47	28	1.70	4	1.22	17	0.47
02122	53.2	31	22,623		0.00	72	2.64	9	1.16	2	1.29	18	1.05
02128	58.2	31	32,178	2	12.74	26	0.98	17	1.47	4	1.74	34	1.33
02134	58.8	39	18,975		0.00	23	2.62	7	0.98	1	0.70	9	0.57
02135	58.8	30	37,089		0.00	23	0.83	8	0.53	1	0.33	33	0.98
02130	61.3	34	38,089		0.00	65	1.43	15	1.15		0.00	26	0.90
02120		60	11,358		0.00	24	1.41	6	1.59	1	1.33	5	0.60
02215		49	16,487		0.00	1	0.20	1	0.16	1	0.62	3	0.22
02115		43	25,140		0.00	16	1.40	3	0.31	1	0.51	16	0.74
02111		38	3,950		0.00	2	1.02	5	4.64		0.00	0	0.00
02127		35	30,667		0.00	52	2.17	22	1.99	3	1.36	31	1.27
02150		34	25,480		0.00	33	1.03	13	1.49	1	0.57	15	0.78
02139		33	32,682		0.00	34	1.91	14	1.27	3	1.36	11	0.45
02141		32	10,413		0.00	12	1.14	3	0.82		0.00	8	0.74
02129		29	13,364		0.00	14	1.18	2	0.43		0.00	10	0.97
02145		27	24,647		0.00	23	0.96	8	0.94	2	1.18	18	0.96
02143		25	26,570	1	9.64	8	0.26	8	0.86		0.00	17	0.82
02114		25	11,658		0.00	2	0.32	6	1.91	2	2.38	6	0.65
02140		23	16,345		0.00	21	1.40	11	1.76	1	0.80	11	0.80
02131		22	32,190		0.00	60	1.70	21	1.81	8	2.58	31	1.21
02148		21	53,664		0.00	19	1.07	17	0.76	4	0.89	61	1.03
02109		21	2,483		0.00		0.00		0.00		0.00	1	0.60
02151		21	42,374		0.00	21	0.82	17	1.12	3	0.99	32	0.96
02110		21	1,713		0.00		0.00		0.00		0.00	2	1.35
02108		20	3,719		0.00	1	0.60	1	0.68		0.00	4	1.20
02149		20	37,196		0.00	19	0.56	27	2.04	5	1.89	23	0.79
02045		20	9,714		0.00	22	3.62	7	2.19	4	6.27	8	1.13
02138		19	35,378		0.00	8	0.30	12	0.89	4	1.48	23	0.77
02144		19	26,675		0.00	12	0.62	12	1.20	1	0.50	22	0.99
02163		18	1,295		0.00	4	3.13		0.00		0.00	1	1.40
02168		18	53,386		0.00	24	0.65	23	1.21	3	0.79	53	1.26
02169		18	54,004		0.00	126	3.61	11	0.55	1	0.25	62	1.39
02136		18	25,424		0.00	33	1.65	22	2.39	6	3.26	31	1.52
02170		16	13,309	1	16.34	21	1.86	3	0.80		0.00	17	1.53
02189		16	14,205		0.00	10	1.02	4	0.83	1	1.04	8	0.76
02155		15	58,620		0.00	19	0.43	23	1.09	1	0.24	48	0.99
02154		15	58,200		0.00	18	0.40	7	0.34	5	1.21	43	0.94
02167		15	16,631		0.00	3	0.46	5	0.73	1	0.73	24	1.58
02162		14	1,446		0.00		0.00		0.00		0.00	3	2.28
02188		14	15,333		0.00	10	0.80	5	0.92		0.00	11	0.91
02152		14	19,543		0.00	8	0.74	2	0.28		0.00	12	0.76

SENTINEL HEALTH EVENTS BY ZIP CODE
BOSTON

ZIPCODE	IMU SCORE	POVERTY	TOTPOP	RHEUMATIC N	RHEUMATIC RISK	INFANT DEHYDRATION N	INFANT DEHYDRATION RISK	CERVICAL CANCER HOSPITAL N	CERVICAL CANCER HOSPITAL RISK	CERVICAL CANCER TUMOR REGISTRY N	CERVICAL CANCER TUMOR REGISTRY RISK	BREAST CANCER TUMOR REGISTRY N	BREAST CANCER TUMOR REGISTRY RISK
02171		13	17,540		0.00	24	1.78	3	0.47	1	0.79	9	0.64
02172		13	34,384		0.00	22	0.72	23	1.76	2	0.76	31	1.07
02072		13	26,434	1	5.98	4	0.15	4	0.46		0.00	16	0.84
02053		12	8,452		0.00	2	0.27		0.00		0.00	9	1.56
02048		12	13,417		0.00	3	0.17		0.00	1	1.22	8	0.89
02041		12	1,184		0.00		0.00		0.00		0.00	1	1.14
02191		12	9,983		0.00	6	0.49	1	0.30	1	1.46	11	1.48
02158		12	13,977		0.00	2	0.22	3	0.59	1	0.99	12	1.07
02056		12	6,242		0.00		0.00		0.00		0.00	3	0.87
02164		12	2,560		0.00	1	0.30		0.00		0.00	1	0.49
02038		11	16,316		0.00	3	0.17	2	0.35	1	0.87	18	1.41
02160		11	9,490		0.00	3	0.33	2	0.56		0.00	9	1.15
02180		11	18,281		0.00	7	0.55	3	0.46	3	2.31	23	1.60
02132		11	26,678		0.00	9	0.42	8	0.80		0.00	31	1.40
02174		11	48,219		0.00	16	0.50	22	1.22	5	1.39	42	1.06
02035		11	14,148		0.00	3	0.20		0.00		0.00	25	2.55
02050		11	17,413		0.00	8	0.40	3	0.67	1	0.95	11	0.95
02093		11	7,580		0.00	1	0.15	2	0.82	3	6.13	5	0.92
02190		11	16,080		0.00	10	0.70	4	0.75	1	0.94	12	1.02
02019		11	14,268		0.00		0		0.00		0.00	5	0.54
02062		10	29,892		0.00	10	0.47		0.00	2	0.94	30	1.28
02176		10	33,822		0.00	10	0.30	4	0.34	2	0.85	29	1.11
02161		9	6,694		0.00	8	1.69		0.00		0.00	8	1.52
02166		9	6,671		0.00	2	0.48	5	1.93		0.00	8	1.05
02187		9	8,725		0.00	2	0.42	1	0.32		0.00	2	0.28
02026		9	25,298		0.00	2	0.14	5	0.58	1	0.58	26	1.36
02054		9	8,903		0.00	4	0.50	1	0.46		0.00	4	0.84
02178		9	26,185		0.00	4	0.17	8	0.81		0.00	21	0.97
02186		8	17,442		0.00	6	0.40	7	1.12	2	1.60	21	1.52
02165		8	11,867		0.00	7	0.84	1	0.24	2	2.41	7	0.76
02060		8	7,141		0.00	1	0.18		0.00		0.00		0.00
02184		8	36,156		0.00	31	1.27	30	2.40	5	2.00	27	0.98
02066		8	8,999		0.00	5	0.68	4	1.34		0.00	6	0.91
02021		7	17,731		0.00	2	0.13	2	0.35		0.00	10	0.80
02159		7	17,726		0.00	3	0.31	2	0.31	1	0.78	18	1.26
02030		7	4,703		0.00	2	1.66	11	7.40	2	6.72	4	1.22
02081		6	15,696		0.00	3	0.17	3	0.63	1	1.05	9	0.85
02043		6	19,983		0.00	10	0.62		0.00		0.00	12	0.85
02025		6	7,174		0.00	1	0.19		0.00		0.00	4	0.76
02181		6	26,288		0.00	5	0.29	1	0.10	1	0.50	24	1.09
02067		6	13,628		0.00	5	0.34	1	0.24		0.00	8	0.85
02194		6	8,370		0.00	1	0.14		0.00		0.00	9	1.39
02061		6	9,182		0.00	1	0.14		0.00		0.00	7	1.13
02192		6	19,531	1	8.18	4	0.36		0.00		0.00	20	1.38
02173		6	29,435		0.00	4	0.20	4	0.40	2	1.00	23	1.04
02032		6	2,495		0.00		0.00		0.00		0.00	3	1.67
02090		5	13,212		0.00	3	0.59	3	0.70	1	1.17	9	0.95
02193		5	11,247		0.00	1	0.16	1	0.25		0.00	10	1.12
02052		5	10,341			3	0.36		0.00		0.00	8	0.85
02168		4	5,873		0.00		0.00	2	1.01		0.00	6	1.36
			1,954,849	9	0.03	1,597	75.29	668	0.80	137	0.16	1,530	1.77

SENTINEL HEALTH EVENTS BY ZIP CODE
BOSTON

ZIPCODE	IMU SCORE	POVERTY	TOTPOP	DIABETES N	DIABETES RISK	HYPERTENSION N	HYPERTENSION RISK	ASTHMA N	ASTHMA RISK	MEASLES N	MEASLES RISK	TUBERCULOSIS N	TUBERCULOSIS RISK	LOW BIRTH WEIGHT N	LOW BIRTH WEIGHT RISK
02119	38.4	50	24,468	252	2.72	125	2.80	22	5.01		0.00	46	8.28	436	1.52
02121	38.4	47	24,393	162	1.82	81	1.89	24	5.02		0.00	165	19.77	313	1.46
02118	46.8	42	19,945	171	2.03	89	2.19	8	3.31	1	0.58		0.00	143	1.37
02116	46.8	26	19,942	37	0.38	17	0.37	1	1.42	3	5.88		0.00	47	1.25
02125	47.8	40	29,163	165	1.46	76	1.40	14	2.90		0.00		0.00	242	0.99
02126	49.6	29	26,783	165	1.84	03	2.12	14	2.85	1	0.29	31	3.28	285	1.19
02113	53.1	28	6,830	22	0.69	9	0.59		0.00		0.00		0.00	4	0.46
02124	53.2	36	49,335	352	1.86	3	2.22	27	5.18	1	0.17		0.00	742	1.24
02122	53.2	31	22,523	139	1.53	66	1.50	3	0.94		0.00		0.00	45	0.85
02128	58.2	31	32,178	173	1.27	86	1.31	5	1.31	3	1.10	16	1.25	146	0.73
02134	58.8	39	18,875	80	0.80	31	0.73	5	4.38	7	8.86	30	3.82	93	0.9
02135	58.8	30	37,089	208	1.22	97	1.18	12	4.93	12	6.02	37	2.31	149	0.76
02130	61.3	34	36,089	168	1.12	95	1.32	10	2.17	2	0.61	23	1.84	237	0.99
02120		50	11,358	61	1.38	42	1.97	5	2.72		0.00		0.00	120	1.29
02215		49	16,487	24	0.29	11	0.28	1	4.72		0		0.00		
02115		43	25,140	63	0.51	41	0.68		0.00	1	2.81		0.00	178	0.86
02111		38	3,950	20	1.16	5	0.60		0.00		0.00		0.00	203	0.85
02127		35	30,667	210	1.62	83	1.33	1	0.27		0.00	17	1.40	161	1.51
02150		34	25,480	148	1.43	64	1.29	5	1.40	1	0.39	12	1.24		
02139		33	32,682	140	0.96	76	1.08	2	0.69		0.00		0.00		
02141		32	10,413	65	1.49	27	1.28		0.00		0.00		0.00		
02129		29	13,364	60	1.07	30	1.11		0.00		0.00	12	2.28	39	0.5
02145		27	24,647	99	0.98	48	0.99	1	0.29		0.00		0.00		
02143		25	25,570	142	1.28	85	1.59	2	0.78	5	2.75	29	2.79		
02114		25	11,658	30	0.53	8	0.29		0.00		0.00	1	0.19	23	0.74
02140		23	16,345	73	1.04	45	1.33	3	1.66		0.00	1	0.16		
02131		22	32,190	181	1.35	69	1.07	7	1.70		0.00	10	0.80	63	0.65
02146		21	53,564	227	0.93	109	0.92	2	0.49	20	6.86	21	0.92		
02109		21	2,483	9	0.74	3	0.51		0.00		0.00		0.00	11	0.56
02151		21	42,374	264	1.40	98	1.12	2	0.41	1	0.29	14	0.83		
02110		21	1,713	3	0.36	7	1.71	1	27.40		0.00		0.00		
02108		20	3,719	4	0.22	7	0.81		0.00		0.00		0.00	7	0.5
02149		20	37,195	292	1.88	117	1.56	1	0.21	2	0.60	9	0.62		
02045		20	9,714	57	1.48	19	1.02		0.00		0.00	2	0.55		
02138		19	35,376	152	0.92	29	0.36		0.00	6	4.12	64	4.13		
02144		19	26,675	90	0.76	56	1.00	3	1.07		0.00		0.00		
02163		18	1,295	3	0.47	0	0.00		0.00		0.00		0.00		
02148		18	53,386	202	0.91	97	0.90	3	0.44	2	0.41	18	0.86		
02169		18	54,004	342	1.47	268	2.39	3	0.50	2	0.47	24	1.10		
02136		18	25,424	195	1.86	102	1.95	4	1.37	1	0.48	15	1.48	96	0.76
02170		16	13,309	123	2.16	54	1.97	1	0.67		0.00		0.00		
02189		16	14,205	75	1.30	34	1.22		0.00		0.00		0.00		
02155		15	58,520	158	0.63	46	0.39	1	0.14	3	0.60	14	0.60		
02154		15	58,200	79	0.31	27	0.22		0.00	32	7.37	17	0.72		
02167		15	16,631	79	1.05	37	1.02		0.00	2	2.04		0.00		
02162		14	1,446	13	2.07	3	0.99		0.00		0.00	1	1.70		
02188		14	15,333	84	1.33	46	1.51	1	0.49		0.00	9	1.82		
02152		14	19,543	95	1.13	103	2.63	1	0.47	3	1.96	8	1.01		

SENTINEL HEALTH EVENTS BY ZIP CODE
BOSTON

ZIPCODE	INU SCORE	POVERTY	TOTPOP	DIABETES N	DIABETES RISK	HYPERTENSION N	HYPERTENSION RISK	ASTHMA N	ASTHMA RISK	MEASLES N	MEASLES RISK	TUBERCULOSIS N	TUBERCULOSIS RISK	LOW BIRTH WEIGHT N	LOW BIRTH WEIGHT RISK
02171		13	17,640	66	0.88	43	1.19	4	1.99		0.00		0.00		
02172		13	34,384	119	0.79	51	0.70	5	1.47	1	0.41	12	0.86		
02072		13	26,434	62	0.59	20	0.40		0.00		0.00	8	0.81		
02053		12	8,452	8	0.25		0.00		0.00		0.00		0.00		
02048		12	13,417	27	0.53	1	0.04		0.00		0.00	2	0.42		
02041		12	1,184	4	0.84	1	0.44		0.00		0.00		0.00		
02191		12	9,983	37	0.90	18	0.91	1	0.76		0.00		0.00		
02158		12	13,977	47	0.78	22	0.76		0.00	8	7.39	1	0.16		
02056		12	6,242	3	0.12	2	0.17		0.00		0.00	1	0.44		
02164		12	2,560	16	1.49	4	0.77		0.00		0.00		0.00		
02038		11	18,315	26	0.37	2	0.06		0.00		0.00	2	0.30		
02160		11	9,490	32	0.79	28	1.43	1	0.94		0.00		0.00		
02180		11	18,281	54	0.71	9	0.25		0.00		0.00	2	0.28		
02132		11	26,678	186	1.59	82	1.46	3	1.14	2	1.07	10	0.91	0.46	180
02174		11	48,219	128	0.62	49	0.49	3	0.57	2	0.53	20	1.03		
02035		11	14,148	16	0.33	2	0.07		0.00		0.00	5	0.96		
02050		11	17,413	53	0.82	10	0.32	1	0.30		0.00	2	0.33		
02093		11	7,580	16	0.49	3	0.20		0.00	1	1.24	1	0.35		
02190		11	16,080	51	0.78	40	1.27	1	0.44		0.00		0.00		
02019		11	14,268	17	0.33		0.00		0.00		0	1	0.20		
02062		10	29,892	71	0.57	6	0.10	2	0.54	4	1.51	4	0.34		
02176		10	33,822	57	0.41	15	0.23	2	0.43	1	0.30	2	0.16		
02161		9	6,694	12	0.43	9	0.66		0.00		0.00		0.00		
02166		9	6,671	26	0.96	19	1.35		0.00		0.00		0.00		
02187		9	8,725	16	0.44	14	0.79	2	1.83		0.00		0.00		
02026		9	25,298	91	0.87	26	0.52	4	1.16	1	0.41	7	0.72		
02054		9	6,903	14	0.52	7	0.54		0.00		0.00	3	1.20		
02178		9	26,185	82	0.73	56	1.03	1	0.35	1	0.49	6	0.57		
02186		8	17,442	125	1.70	98	2.71	1	0.47	1	0.66	2	0.29		
02165		8	11,867	60	1.01	17	0.71		0.00		0.00		0.00		
02060		8	7,141	7	0.25		0.00		0.00		0.00		0.00		
02184		8	36,156	184	1.23	107	1.48	1	0.21		0.00	2	0.14		
02066		8	8,999	52	1.44	28	1.61	1	0.75		0.00	2	0.59		
02021		7	17,731	63	0.76	33	0.98		0.00		0		0.00		
02159		7	17,726	47	0.62	24	0.66		0.00		0.00	11	1.55		
02030		7	4,703	7	0.37		0.00	1	1.32	1	1.86		0.00		
02081		6	15,696	29	0.46	10	0.33		0.00		0.00	2	0.34		
02043		6	19,983	58	0.74	24	0.64	1	0.30		0.00	5	0.68		
02025		6	7,174	22	0.76	9	0.64		0.00		0	3	1.10		
02181		6	26,268	36	0.33	28	0.53	2	0.59		0.00	1	0.10		
02067		6	13,628	31	0.58	12	0.47	2	0.89		0.00	2	0.40		
02194		6	8,370	19	0.54	1	0.06	1	0.99		0		0.00		
02061		6	9,182	25	0.72	9	0.54	1	0.69		0.00		0.00		
02192		6	19,531	32	0.41	11	0.29	2	0.87		0.00	5	0.68		
02173		6	29,435	72	0.59	14	0.24		0.00	1	0.35	3	0.26		
02032		6	2,495	7	0.69	3	0.61		0.00		0.00		0.00		
02090		5	13,212	36	0.68	5	0.19		0.00	32	22.30		0.00		
02193		5	11,247	12	0.26	10	0.45		0.00	2	1.84	1	0.23		
02052		5	10,341	10	0.25	5	0.26	1	0.56	1	0.79		0.00		
02168		4	5,873	10	0.42	2	0.17		0.00		0.00		0.00		
			1,954,849	8,207	5.12	3,961	2.47	239	0.73	170	0.52	774	0.48	88.2	3538

APPENDIX B

DIAGNOSIS CODES WHICH COMPRISE THE HOSPITAL-BASED SENTINEL EVENTS

APPENDIX B

DIAGNOSIS CODES WHICH COMPRISE THE HOSPITAL-BASED SENTINEL EVENTS

	ICD-9 Codes	Procedure Codes
A. Hyperbilirubinemia with exchange transfusion (principal diagnosis only)		
1. Jaundice, unspecified	782.4	99.01
2. Neonatal jaundice associated with pre-term delivery	774.2	99.01
3. Unspecified fetal and neonatal jaundice	774.6	99.01
4. Kemicterus not due to isoimmunization	774.7	99.01
B. Dehydration/Gastroenteritis		
1. Volume depletion	276.5	
2. Hypersomolality and/or hypernatremia	276.0	
3. Hyposomolality and/or hyponatremia	276.1	
4. Toxic gastroenteritis and colitis	558.2	
5. Other and unspecified non-infectious gastroenteritis and colitis	558.9	
6. Enteritis due to specified virus	008.6	
7. Other organism, not elsewhere classified	008.8	
8. Infectious colitis, enteritis, and gastroenteritis	009.0	
9. Salmonella gastroenteritis	003.0	

APPENDIX B

DIAGNOSIS CODES WHICH COMPRISE THE HOSPITAL-BASED SENTINEL EVENTS (CONTINUED)

	ICD-9 Codes	Procedure Codes
C. Asthma (principal diagnosis only)		
1. Childhood	493.0	
D. Peritonitis (principal diagnosis only)		
1. Peritonitis	540.0	
2. Peritoneal abscess	540.1	
E. Rheumatic Fever		
1. Rheumatic Fever without heart involvement	390.0	
2. Acute rheumatic pericarditis	391.0	
3. Acute rheumatic endocarditis	391.1	
4. Acute rheumatic myocarditis	391.2	
5. Other acute rheumatic heart disease	391.8	
6. Acute rheumatic heart disease, unspecified	391.9	
F. Advanced Colorectal Cancer (principal diagnosis only)		
1. Hepatic flexure	153.0	
2. Transverse colon	153.1	
3. Descending colon	153.2	
4. Sigmoid colon	153.3	
5. Cecum	153.4	
6. Appendix	153.5	

APPENDIX B

DIAGNOSIS CODES WHICH COMPRISE THE HOSPITAL-BASED SENTINEL EVENTS (CONTINUED)

	ICD-9 Codes	Procedure Codes
7. Ascending colon	153.6	
8. Splenic flexure	153.7	
9. Other specified sites of large intestine	153.8	
10. Colon, unspecified	153.9	
11. Recolosigmoid juncture	154.0	
12. Rectum	154.1	
13. Anal canal	154.2	
14. Anus, unspecified	154.3	
15. Other	154.8	
G. Invasive Cervical Cancer (principal diagnosis only)		Exclude:
1. Endocervix	180.0	67.1
2. Exocervix	180.1	67.2
3. Other specified sites of cervix	180.8	67.3
4. Cervix uteri, unspecified	180.9	

APPENDIX B

DIAGNOSIS CODES WHICH COMPRISE THE HOSPITAL-BASED SENTINEL EVENTS (CONTINUED)

	ICD-9 Codes	Procedure Codes
H. Uncontrolled Diabetes (principal diagnosis only)		
1. Diabetes with ketoacidosis: adult onset	250.10	
2. Diabetes with ketoacidosis; juvenile	250.11	
3. Diabetes with hypersomolar coma: adult onset	250.20	
4. Diabetes with hypersomolar coma: juvenile	250.21	
5. Diabetes with other coma: adult onset	250.30	
6. Diabetes with other coma: juvenile	250.31	
7. Diabetes with unspecified complication: adult onset	250.90	
8. Diabetes with unspecified complication: juvenile	250.91	
9. Diabetes with gangrene: adult onset	250.70	and 785.4
10. Diabetes with gangrene: juvenile	250.71	and 785.4

APPENDIX B

DIAGNOSIS CODES WHICH COMPRISE THE HOSPITAL-BASED SENTINEL EVENTS (CONTINUED)

	ICD-9 Codes	Procedure Codes
I. Uncontrolled Hypertension (principal diagnosis only)		
1. Malignant essential hypertension	401.0	
2. Benign essential hypertension	401.1	
3. Unspecified essential hypertension	401.9	
4. Malignant hypertensive heart disease without congestive heart failure	402.0	
5. Malignant hypertensive heart disease with congestive heart failure	402.01	
6. Benign hypertensive heart disease without congestive heart failure	402.10	
7. Benign hypertensive heart disease with congestive heart failure	402.11	
8. Unspecified hypertensive heart disease without congestive heart failure	402.90	
9. Unspecified hypertensive heart disease with congestive heart failure	402.91	
10. Hypertensive encephalopathy	437.2	
11. Intrarcerebral hemorrhage with hypertension	431 and 401.0	
12. Acute, but ill-defined, cerebrovascular disease	436 and 401.0	

APPENDIX C
EXAMPLE TABLE LAYOUT

DATA SOURCE: NORTH CAROLINA

YEAR -

APPENDIX C

TUBERCULOSIS

NUMBER OF CASES

ALL RACES

ZIP CODES	TOTAL	SEX		AGE		AGE							
		MALE	FEMALE	MEAN	RANGE	<17	17-25	26-34	35-44	45-54	55-64	65-74	75+

APPENDIX D

LIST OF ADVISORY COMMITTEE MEMBERS

APPENDIX D

INCORPORATING HEALTH STATUS INDICATORS INTO THE MEASUREMENT OF MEDICAL UNDERSERVICE

ADVISORY COMMITTEE MEMBERS

1. Donna Bacchi, M.D.
   Pediatrician
   Former Associate Medical Director
   Brownsville Community Health Center
   Brownsville, Texas

2. Timothy Carey, M.D.
   Internist
   University of North Carolina at Chapel Hill
   Chapel Hill, North Carolina

3. Andy Jordan
   BHCDA Representative
   Region III
   Philadelphia, Pennsylvania

4. JoAnne Lukomnik, M.D.
   Internist
   Jersey City Medical Center
   Jersey City, New Jersey

5. David Siscovik, M.D.
   Epidemiologist
   University of Washington
   Seattle, Washington

6. Joyce Young, M.D.
   BHCDA Representative

APPENDIX E
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